TRANSACTIONS

of the

American Society for Steel Treating

Vol. VI November, 1924 No. 5

WHAT OTHERS SAY

IT is indeed gratifying to the members of the A. S. S. T. to know that their efforts are being appreciated and to know that they are fulfilling a useful need in the field that the Society covers. In the October 2nd issue of *Iron Trade Review* we read:

"The 1924 exposition of the American Society for Steel Treating, held at Commonwealth Pier, Boston, last week, may be classed as the largest and most complete yet conducted by that society.

"With a registration of 1,210 of its members, which is 40 per cent of the total membership, the American Society for Steel Treating at its Boston convention last week established a record having few, if any, parallels in the history of American technical associations of national scope. The total attendance for the week was 43,000, which exceeds all previous records of the society. Friday had the largest single day's attendance of 15,000. All phases of the convention contributed to its success. The technical program was exceptionally well balanced and the exhibits, described elsewhere in this issue, covered a broader field of application than those of previous conventions.

"Through the medium of its annual convention, the American Society for Steel Treating again has provided an impressive demonstration of the size and importance of that branch of industry which is identified with the treating and finishing operations on steel. It is safe to say that no American technical organization six years after birth, has conducted a national convention and exhibit even remotely approaching in extent and quality the Boston event."

American Machinist, in the October 2nd issue, under a title

of "Record Attendance at Enthusiastic Convention of Steel Treaters," comments as follows:

"Each year, since the first meeting of the American Society for Steel Treating, held in 1919, the verdict on the conventions has been: 'Better than ever.' The sixth annual convention, held in Boston from September 22nd to 26th, inclusive, was no exception, both the program and the exhibition surpassing anything that has gone before. The total attendance was estimated at 40,000.

"The success of the convention and exhibition from the steel-treater's point of view and from that of the makers of equipment for the steel-treater was marked. The variety and completeness of the exhibits bore witness to the truth of the statement. They included steel and steel products, alloy, welding and cutting equipment, gas appliances, all types of furnaces, insulating materials, fire brick, rock products, instruments for measuring, testing and recording, salts, washing machines, compounds, heat-enduring materials, lights, burners, castings, automatic furnace controls, cleaning materials, speed transformers, pots, retorts, conveyor chains, forgings, belting, dies, lubricating systems, portable elevators and stackers, gears, testing machines, sand-blast equipment, air compressors, cutlery and others.

"That the A. S. S. T. has constantly been improving in the eyes of the professional and technical world, internationally as well as in this country, was evidenced by the presence at the meetings of such men as Dr. Kotaro Honda, director of the department of metallurgical science at the Tohoku Imperial University, Sendai, Japan, and his associate, Dr. Toyato Ishigaki; Dr. George Bulle and Dr. Herman Bleibtreu, representing the German Iron and Steel Institute; Dr. Edward Schmidt of the Limited Co., formerly the Skoda Works, Czechoslovakia, and William H. Patchell, president of the Institute of Mechanical Engineers, London."

Canadian Machinery

The following remarks have been made by *Canadian Machinery* in their October 9th issue:

"With a registration of 1,210 of its membership of 3,026, the Boston convention of the American Society for Steel Treating established a record, perhaps, without parallel in the history of

technical associations of national scope, the total attendance being 43,000.

"All phases of the convention contributed to its success, the technical program being unusually well balanced and the exhibits covering practically every phase of the iron and steel industry."

Iron Age

In a thirteen-page review of the Convention, *Iron Age* in their October 2nd issue say:

"After five years of spectacular growth the American Society for Steel Treating celebrated its sixth anniversary in Boston last week, September 22nd to 26th. In several respects the meeting made history. The technical sessions, ten in all, were marked by particularly high-grade contributions from leading American and foreign authorities and by the presence of more prominent metallurgists and scientists, including a number from abroad, than have been seen at a like meeting in recent years. The attendance of over 40 per cent of the Society's membership, or 1,210 out of 3,000, was also a testimony to the active interest in the organization, and there was general comment on the large turnout at all the technical sessions.

"The steel exposition was the largest of the kind that has been held. Covering 150,000 square feet of floor space, of which 25,000 square feet was taken up by a representative machine tool and machinery display, it exceeded last year's in actual paid-for space by 33½ per cent. It was the common observation that the exhibits of this year represented more new developments, both in machinery and heat-treating equipment and products, than had been seen at any previous show."

Chemical and Metallurgical Engineering

The October 6th issue of *Chemical and Metallurgical Engineering* gives the following comments referring to the convention:

"Although the phrase, 'best yet,' has been overworked, it is necessary to use it again to describe the annual convention and steel show of the American Society for Steel Treating at Boston, September 22 to 26. The exposition was held at the Commonwealth Pier in Boston Harbor, the only building in the city capable of containing this—the largest annual industrial exposition in the country."

WILLIAM SANFORD BIDLE
Nominated for President of the American Society for Steel Treating for 1925

W. H. EISENMAN
Renominated for Secretary for Two Years

F. E. McCLEARY
Nominated for Director for Two Years

F. G. HUGHES
Nominated for Director for Two Years

P. D. MERICA
Nominated for Director for One Year

BIOGRAPHIES OF NOMINEES FOR NATIONAL OFFICES OF THE SOCIETY

William Sanford Bidle

Nominated President of the Society
for one year

William S. Bidle was born in Cleveland, June 26, 1872, and attended the Cleveland public schools. He was graduated from Case School of Applied Science in 1893, receiving the degree of B. S. In 1898, he received the degree of M. E., from the same college. While at Case, Mr. Bidle participated in many campus activities and was an excellent student, as evidenced by the fact that he was made a member of Tau Beta Pi and Sigma Xi fraternities.

From 1896 to 1912, he was manager of the turn-buckle department of the Cleveland City Forge and Iron Company, and from 1913 to date, he has been president of the W. S. Bidle Company, engaged in commercial steel treating, cold drawing and testing.

As is well known to many, Mr. Bidle has given valuable service to the work of the American Society for Steel Treating, being a charter member of the Cleveland chapter as well as being a past chairman. In 1920 and 1921, he was national treasurer of the Society; 1922 and 1923, second vice-president and in 1923 and 1924, he was and is first vice-president.

William Hunt Eisenman

Renominated Secretary of the Society
for two years

W. H. Eisenman was born in Jamestown, Ohio, July 7, 1882, and was graduated from Kenyon College, receiving the degree of Ph. B. He took post graduate work at Leland Stanford, Jr., University, specializing in law and sciences and received an M. A. degree for special research work in chemistry. In addition, he completed post graduate work at Morningside College and Ohio State University.

Mr. Eisenman was successively principal of high school; instructor in chemistry, Racine College; head of chemistry department of large high school and superintendent of schools. Finally he was made secretary of the American Society for Steel Treating, which position he holds at the present time.

Frederick George Hughes

Nominated Director of the Society for Two Years

Frederick George Hughes, Vice-President of The New Departure Manufacturing Company, Bristol, Conn., was born May 1, 1878, at West Cornwall, Conn., the son of George and Mary A. (Volmiller) Hughes. He was educated in the public schools of Bridgeport, Conn., later entering Sheffield Scientific School at Yale University, graduating therefrom in 1900 with degree of Ph. B.

His first occupation after completing his collegiate course was in 1900, as engineer with Bethlehem Steel Company at South Bethlehem, Pa., later becoming assistant engineer of experimental ordnance, remaining there until 1905, after which he became chief engineer of the Driggs Seabury Ordnance Corporation of Sharon, Pa., remaining there until 1911, when he went to Bristol, Conn., and entered the employ of the New Departure Manufacturing Company, as chief engineer, and in 1914 was made production manager; assistant general manager in 1916, and director and vice-president in 1919.

He is also a director of the Bristol Realty Company; president of the Bristol Chamber of Commerce; director of Connecticut Chamber of Commerce; member of Endee Club of Bristol; Chippanee Country Club of Bristol; Society of Automotive Engineers; American Society of Mechanical Engineers; and of the American Society for Steel Treating. He was for several years chairman of the Ball and Roller Bearings Standard Division of the Society of Automotive Engineers.

During the World's war, Mr. Hughes was an advisory engineer to the Quartermaster department. He was also a member of the War Service committee on bearings.

Mr. Hughes was married October 25, 1905, to Miss Edith Crawford, of Nazareth, Pa., and they have one daughter, Madeline Crawford Hughes. Residence, Bristol, Conn.

F. E. McCleary

Nominated as Director of the Society for Two Years

F. E. McCleary was born in Steubenville, Ohio, in 1882. In 1901 and 1902 he attended Mt. Union College, and from 1902 to

1906 he was a student at Ohio State University, receiving his degree in June, 1906. Following graduation, he was engaged as chemist for the Union Pacific railroad, Omaha, in 1906-1907; was chemist for the Rock Island railroad, Chicago, from 1907 to 1911; was assistant metallurgist with General Motors Co., Detroit, in 1911-1912, and from 1912 to 1914, was metallurgist with the same company. From 1914 to the present time, Mr. McCleary has been metallurgical engineer with Dodge Brothers, Detroit, having complete jurisdiction over all materials used in the production of Dodge cars.

Mr. McCleary is a member of the Society of Automotive Engineers, the American Society for Testing Materials and the British Iron and Steel Institute.

Paul D. Merica

Nominated Director of the Society for One Year

Paul D. Merica was born in Indiana and received most of his early education there, attending De Pauw University, graduating later, however, from the University of Wisconsin, receiving his degree in Chemistry.

After an additional year in the physics department of this university he received an invitation from the government of the Province of Chekiang, China, to teach chemistry at the Provincial College of this province. This was accepted and he spent two years at Hang Chow, China, engaged in the interesting occupation of introducing our Western civilization among the Chinese. It may be added that he had excellent opportunity at this time to realize the remarkable ability of the educated class of Chinese in Western arts and their future potentialities when their interest is really aroused.

Leaving this interesting Oriental civilization rather reluctantly, Mr. Merica, in 1911, went to Berlin, primarily to take up again his chemical and physical studies, first at the Chemical Institute of Professor Emil Fischer and, later, at the Technische Hochschule at Charlottenburg. It was there that he first became definitely interested in metallurgy through his work in the metallographic laboratories of Professor H. Hanemann, where he remained until 1914, taking finally his Ph. D. in chemistry and metallurgy. It was just about six months before the opening of the war that he

returned, after a five years' absence, to this country to engage in metallurgical research work.

After a few months spent at the Engineering Experimental Station of the University of Illinois on a special research on the embrittlement of boiler steel in association with Professor S. W. Parr, Dr. Merica joined the metallurgical staff of the U. S. Bureau of Standards under its then chief, Dr. G. K. Burgess.

At the Bureau his attention was engaged, perhaps predominantly, in non-ferrous metals, particularly wrought brass and aluminum alloys. During the years 1914-1916 much attention was given by the Bureau of Standards to certain failures of brasses and bronzes in the construction of the Catskill Aqueduct, and Dr. Merica, in collaboration with others, conducted several investigations into the matter, publishing later a number of papers on the subject. Subsequently, during the period of our entry into the war, the production of high strength light aluminum alloys in this country became a matter of considerable importance, and he had charge at the Bureau of Standards of the investigational work along these lines. This resulted, among other things, in the determination of the nature and mechanism of the heat-treatment of aluminum alloys of the Duralumin type and the improvement of the technique of heat treatment of these alloys. At this time Dr. Merica was assistant Chief of the Metallurgical Division of the Bureau of Standards.

In 1919 Dr. Merica left the Bureau of Standards to associate himself with The International Nickel Company at its Orford plant, where he later became Superintendent of Research. In 1922 a new department of this company was organized, the Development and Research Department, for the purpose of developing new commercial uses for nicked and new nickel products. Dr. Merica became associated with this department and at present is Director of Research for The International Nickel Company, in New York City, and assistant manager of its Development and Research Department.

THE SIXTH ANNUAL CONVENTION AND EXPOSITION

THE members of the Boston chapter of the Society are to be congratulated upon the successful way in which they did their part toward the success of the Sixth Annual Convention and Exposition held in Boston, September 22 to 26. The success of this convention was due in no small measure to their untiring efforts.

The number and variety of exhibits at the Boston convention was fully one-third larger than at Pittsburgh last year, and the amount of floor space one-third greater than that used last year. The exhibits were assembled on Commonwealth Pier, the largest covered pier in the world, measuring 1,200 feet long and 200 feet wide, and were divided in three main sections. In the first section were exhibited furnaces and process equipment of all types and varieties, while in the second section, products of steel manufacturers and makers of all kinds of non-ferrous and metal equipment, were shown. The third section was devoted to a live exhibit of machine tools, which was the largest and most complete exhibit that has ever been held. There were more than 175 different exhibitors represented.

The attendance during the five days of the convention was indeed encouraging. There were 1,210 members registered as being in attendance, which is more than 40 per cent of the total membership of the Society. More than 43,000 people viewed the exhibits, while on the closing day, 15,000 were admitted, thus making a record for the Society.

The very large and enthusiastic audience which attended each of the technical sessions, gave proof of the scientific value of the forty-six worthy papers contributed during the Convention. The morning sessions dealt with the more technical and theoretical phases of heat treating problems, while the afternoon programs were devoted to the more practical subjects. A marked feature of the technical program was the ten foreign contributions by prominent metallurgists and scientists.

Monday, September 22nd

The convention was officially opened at 10:00 a. m. in the Ball Room of the Copley Plaza Hotel, Victor O. Homerberg pre-

siding. An address of welcome was given on behalf of Mayor Curley by his representative, Mr. Fox. Mr. Homerberg then gave an address of welcome on behalf of the Boston chapter, which was followed by an address by A. O. Fulton, general chairman of the Boston committees. President George K. Burgess responded to these salutations. Following these preliminary ceremonies, the meeting took the form of a technical session, during which the following papers were presented:

Chairman—Dr. George K. Burgess

The Nature of the Function of Chromium in High Speed Steel —E. C. Bain and M. A. Grossmann, Atlas Steel Corporation.
The Use of Cobalt and Vanadium as Additions to High Speed Steel—Dr. W. Oertel and Dr. ing. F. Poeltzgueter, Germany. (By title.)
The Law of Depression of Freezing Point as Applied to Metallic Alloys—Dr. Kotaro Honda and Toyato Ishigaki, Imperial University, Japan. (By title.)
Magnetic Determination of the Elastic State—A. V. deForest, American Chain Company.

At 1:00 p. m., the exposition officially opened and the registration of members began. At 2:30, the first afternoon technical session was held in the Meeting Room at Commonwealth Pier. This session was a Symposium on Salt Baths as a Heating Medium, A. H. d'Arcambal, presiding. The papers which were presented at this meeting are as follows:

Heat Treatment in Salt Baths—Major A. E. Bellis, Bellis Heat Treating Company.
Salt Baths—Sam Tour, Doehler Die Castings Company.
Fused Salt Baths for the Prevention of Soft Spots in Quenched High Carbon and Carburized Steels—W. J. Merten, Westinghouse Electric and Manufacturing Company.

The exposition remained open until 10:00 p. m.

Tuesday, September 23rd

At 9:30 a. m., the second morning technical session was held in the Ball Room of the Copley Plaza Hotel, Dr. John A. Mathews, being chairman. The following papers were presented:

Density and X-Ray Spectrum of Hardened Ball Steel Drawn at Various Temperatures—K. Heindlhofer and F. L. Wright, SKF Industries, Inc.
The Application of X-Ray Crystal Analysis to Metallurgy—Dr. W. P. Davey, General Electric Company.
Spheroidized Cementite in Hypoeutectoid Steel—R. S. MacPherran and J. Fletcher Harper, Allis-Chalmers Mfg. Co.

L. J. HEATH
Transportation Committee

W. W. CUMMINGS
Ladies' Entertainment Committee

H. E. HANDY
Information Committee

V. O. HOMERBERG
Chairman, Boston Chapter

A. O. FULTON
General Chairman

H. H. HARRIS
Special Arrangements Committee

L. D. HAWKRIDGE
Meetings and Papers Committee

L. E. ZURBACH
Exhibit Committee

G. C. DAVIS
Entertainment Committee

SOME OF THE CHAIRMEN OF THE BOSTON LOCAL CONVENTION COMMITTEE

A New Method of Interpreting Notched-Bar Impact Test Results—Dr. ing. Max Moser, Essen, Germany. (By title.)
A Laboratory Method for the Preparation of Small Steel Bars Differing Only in Carbon Content and the Effect of Changes in Carbide Concentration on the Specific Resistance—E. D. Campbell, University of Michigan and G. W. Whitney, American Smelting and Refining Company. (By title.)
The Microstructure of Austenite and Martensite—F. F. Lucas, Western Electric Company.

The exposition opened the second day at 1:00 p. m. and closed at 10:00 p. m. At 2:30 p. m., the second afternoon technical session was held in the Meeting Room on Commonwealth Pier, Professor H. M. Boylston, presiding. The session was devoted to the discussion of fuels and heating media for the treatment of metals. The papers presented are as follows:

The Intrinsic Value of Heat Sources versus the Floating Economic Value of the B. t. u.—E. F. Collins, General Electric Company.
Selection of Fuel for the Heat Treatment of Metal—J. A. Doyle, W. S. Rockwell Company.
Gas as a Factor in Improving Quality Standards and Lowering Production Costs of Heat Treated Steel—H. O. Loebell, Combustion Utilities Company.

At 9:30 p. m., the annual smoker was held in the National Theater and was attended by a large and enthusiastic audience.

Wednesday, September 24th

At 9:30 a. m., the annual meeting of the Society was held in the Ball Room of the Copley Plaza Hotel, President George K. Burgess, presiding. The order of business for this meeting was the reading of the annual reports of the president, treasurer and the secretary, which are published in full on pages 560, 563 and 565, respectively.

On behalf of the delegates of the chapters, Dr. O. E. Harder made the following report of their meeting held on Monday morning, at which time they sat as a Nominating Committee. Upon motion, duly seconded and carried, the report of the committee was adopted and ordered filed.

The Nominating Committee, 1924, operating under the new Constitution, adopted March 29, 1924, held a meeting in the

Copley-Plaza Hotel, Boston, at 10:30 a. m., September 22nd, 1924, for the purpose of nominating certain officers.

The following members from the various chapters presented credentials:

Chapter	Representative	Chapter	Representative
Boston	H. E. Handy	Northwest	O. E. Harder
Chicago	T. E. Barker	Philadelphia	H. C. Knerr
Cleveland	H. M. Boylston	Pittsburgh	W. J. Merten
Detroit	R. Atkinson	Providence	F. H. Franklin
Hartford	L. A. Lanning	Rochester	Leon Slade
Indianapolis	H. B. Northrup	Rockford	J. A. Nelson
Lehigh Valley	B. F. Shepherd	Schenectady	G. R. Brophy
New Haven	W. G. Aurand	Tri City	C. H. Burgston
New York	Mr. Johnson	Washington	H. J. French

The members assembled then elected Professor O. E. Harder of the Northwest chapter, as chairman and B. F. Shepherd of the Lehigh Valley chapter, as secretary of the meeting.

The Committee's attention was directed to Article II, Section A, of the Constitution of the Society, which makes provision for the Nominating Committee of 1924 to place in nomination, a president, secretary and two directors. There were, however, three vacancies on the Board of Directors, and it was the decision of the Committee to recommend to the Board of Directors, the appointment of a third nominee, selected by the present Nominating Committee, the term of office to be one or two years, at the option of the Board of Directors. With this procedure, it makes it possible to elect two directors at each succeeding election.

The result of the work of the Nominating Committee is as follows:

W. S. Bidle, president of W. S. Bidle Company, Cleveland, nominated for president for one year.

W. H. Eisenman, present secretary of the A. S. S. T., nominated for secretary for two years.

F. G. Hughes, vice-president of New Departure Mfg. Company, Bristol, Conn., nominated for member of the Board of Directors for two years.

F. E. McCleary, metallurgist of Dodge Brothers, Detroit, nominated for member of the Board of Directors for two years.

PAUL D. MERICA, research engineer of International Nickel Company, New York, recommended to the Board of Directors for appointment to fill a vacancy on the Board of Directors.

Following this order of business, the meeting took the form of a technical session, the following papers being presented:

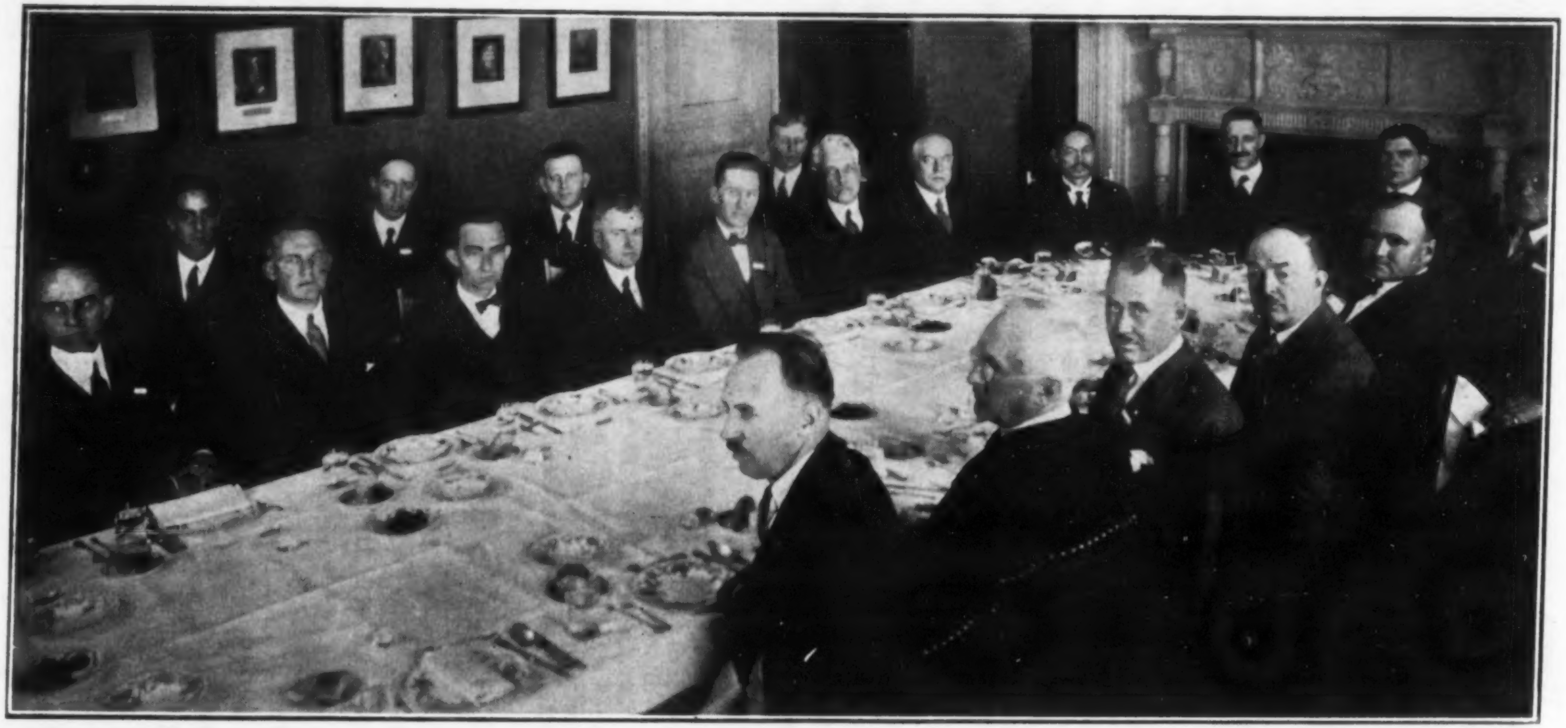
Observations Upon the Making and Use of Tool and Special Alloy Steels—Dr. John A. Mathews, Crucible Steel Company of America.
Some Fundamental Factors for Obtaining Sharp Thermal Curves—Carl Benedicks, K. G. Lund and W. H. Dearden, Stockholm, Sweden. (By title.)
Granulation Hypothesis and the Delta-Gamma Change in Iron-Carbon and Nickel Alloys—Colonel N. T. Belaiew. (By title.)
Correlation of Endurance Properties of Metals—Dr. D. J. McAdam, Jr., Naval Experimental Station, Annapolis.
On the Transformations in Pure Iron—Dr. Kotaro Honda, Imperial University, Japan.

The exposition again opened at 1:00 p. m. and remained open until 10:00 p. m. The afternoon technical session was held at 2:30 p. m. in the Meeting Room on Commonwealth Pier, Colonel A. E. White, presiding. Papers presented at this session were:

The Heat Treatment of Automobile Parts—J. M. Watson, Hupp Motor Car Company (Illustrated with a motion picture.)
Die Records and Their Effects on Die Costs—E. J. P. Fisher, R. Wallace and Sons Mfg. Company.
Heat Treatment of Tool Steel—F. C. A. H. Lantsberry, Jessop Steel Co., Sheffield, England.
Progress in the Manufacture and Use of Clay Refractories—W. G. Owen, Haws Refractories Company.

LUNCHEON IN HONOR OF DR. HONDA

A luncheon given by Dr. George B. Waterhouse, professor of Metallurgy, Massachusetts Institute of Technology, Cambridge, was held on Wednesday, September 24th, at the University Club, Boston, in honor of Dr. Kotaro Honda, the most distinguished metallurgist of Japan and director of the department of metallurgy, Tohoku Imperial University, Sendai. A number of the distinguished metallurgists who attended the convention and others representative of the steel industry were in attendance. Those attending this meeting are as follows: Dr. George K. Burgess, director of the Bureau of Standards; Dr. John A. Mathews, vice-



C. E. MacQuigg G. K. Burgess Kotaro Honda G. B. Waterhouse F. C. A. H. Lantsberry

H. J. French D. J. McAdam E. C. Bain S. L. Hoyt Albert Sauveur

E. F. Cone R. M. Bird F. C. Langenberg P. D. Merica Zay Jeffries J. A. Mathews

O. E. Harder H. M. Boylston

E. D. Campbell, Jr. E. D. Campbell

LUNCHEON IN HONOR OF DR. KOTARO HONDA GIVEN BY DR. G. B. WATERHOUSE

president of the Crucible Steel Company of America; Dr. Albert Sauveur, professor of metallurgy, Harvard University; Dr. Zay Jeffries, research department, Aluminum Company of America and treasurer of the Society; H. M. Boylston, professor of metallurgy, Case School of Applied Science; Dr. S. L. Hoyt, metallurgist, Research Laboratory, General Electric Company; Dr. F. C. Langenberg, metallurgist, Watertown Arsenal; Dr. D. J. McAdam, experimental station, U. S. Navy; C. E. MacQuigg, and E. C. Bain, research laboratories, Union Carbide and Carbon Company; Dr. O. E. Harder, professor of metallography, University of Minnesota; E. F. Cone, associate editor, Iron Age; H. J. French, physicist, Bureau of Standards; E. E. Thum, Linde Air Products Co.; Dr. P. D. Merica, director of research, International Nickel Co., Professor E. D. Campbell, University of Michigan; E. D. Campbell, Jr.; F. C. A. H. Lantsberry, managing director, Jessop Steel Co., Sheffield; R. M. Bird, G. F. Pettinos, Philadelphia.

Those who were unable to attend were: Professor A. E. White, Professor Bradley Stoughton, Professor C. H. Mathewson, Professor O. W. Ellis, Dr. C. A. F. Benedicks, Professor William Campbell, John Howe Hall, H. A. Schwartz, H. S. Rawdon and Professor Henry Fay.

After the luncheon, an informal discussion of various technical problems was introduced by Dr. Honda.

Thursday, September 25th

The morning technical session was called to order at 9:30 a. m. by Dr. Albert Sauveur and the following papers presented:

Quenching Diagrams for Carbon Steels in Relation to Some Quenching Media for Heat Treatment—H. J. French and O. Z. Klopsch, Bureau of Standards.

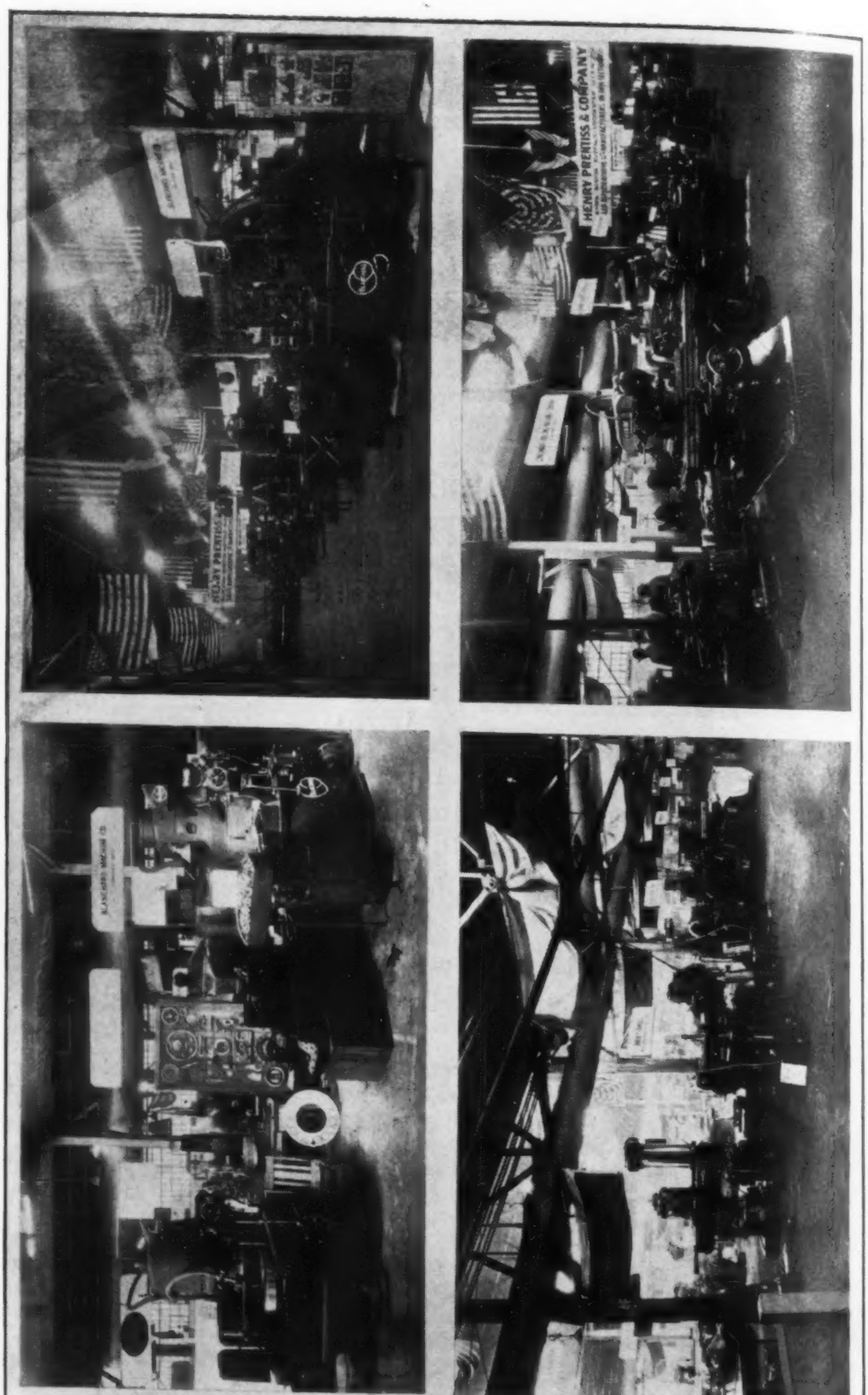
A New Theory of Overstrain and Strength of Materials—H. P. Troendly and G. V. Pickwell, Wm. D. Gibson Company.

X-Ray Tests Applied to the Problems of the Steel Foundry—Dr. H. H. Lester, Watertown Arsenal.

Influence of the Structure "as cast" upon the Manufacture and Qualities of Some Alloyed, Especially High Speed Steels—Dr. ing. Franz Rapatz, Duesseldorf, Germany. (By title.)

The Effect of Heat Treatment on the Properties of Corrosion Resistant Steels—Dr. D. J. McAdam, Jr., U. S. Naval Experimental Station, Annapolis.

The exposition opened at 10:00 a. m. and closed at 5:30 p. m.



SOME VIEWS OF THE MACHINE TOOL SECTION AT THE SIXTH ANNUAL EXPOSITION

in order that the evening might be left open for the annual banquet of the Society.

The afternoon technical session was held at 2:30 p. m. in the Meeting Room on Commonwealth Pier, taking the form of a Hardness Testing Symposium, under the direction of the National Research Council, Dr. H. P. Hollnagel, being chairman. The papers presented at this symposium were:

Comparison of Brinell and Rockwell Hardness of Hardened High Speed Steel—S. C. Spalding, Halcomb Steel Company.
The Relation of Hardness and Impact Measurements to Performance—G. W. Webster, Bellis Heat Treating Company.
Relation Between Rockwell and Brinell Hardness Scales—Irving H. Cowdry, Massachusetts Institute of Technology.
The Ball Indentation Hardness Test—Dr. S. L. Hoyt, General Electric Company.
Report on Hardness Testing Work of A. S. M. E. Committee on Cutting Metals—Major A. E. Bellis, Bellis Heat Treating Company.

At 6:30 p. m., the members and guests of the Society assembled in the Ball Room of the Copley Plaza for the annual Banquet and Dance. The banquet was exceedingly well attended, many distinguished guests being present.

Following the dinner, President Burgess presented our past-president, T. D. Lynch, with a medal, known as the Past-President's Medal, as awarded by the directors of the Society. Dr. Burgess, on behalf of the Board of Directors, then presented to our distinguished guest, Dr. Kotaro Honda, Honorary Membership in the Society, in recogntion of the very valuable contributions which he has made to science. In recognition of work well planned and well done, Francis F. Lucas was then presented with the Henry Marion Howe Medal for 1924, awarded to him for his capable paper entitled, "High Power Photomicrography of Metallurgical Specimens," published in the November, 1923, issue of TRANSACTIONS.

President Burgess then turned the meeting over to Toastmaster S. M. Havens, who in turn introduced Frederick W. Cook, Secretary of State of the Commonwealth of Massachusetts, and following, Dr. W. H. Patchell, president of the Institute of Mechanical Engineers, London, both of whom made very appropriate speeches. Toastmaster Havens next presented W. H. Eisenman, secretary of the Society, who expressed the appreciation of the Society for the assistance that New Englanders and Bostonians rendered toward making the convention a success. The final

speaker, Strickland Gillilan, humorist of Baltimore, also known as the "The Tolerably-Innocent Abroad," was then introduced. Mr. Gillilan entertained his audience for over an hour. At the con-

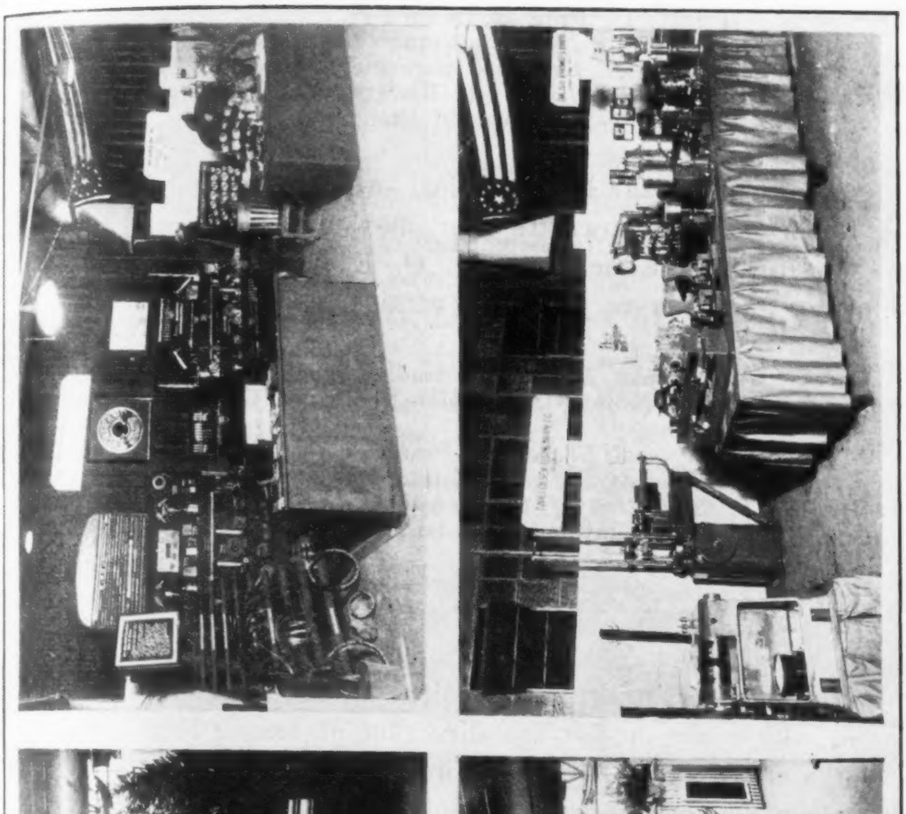
FRANCIS F. LUCAS
Henry Marion Howe Medalist, 1924

clusion of his address, the guests gathered in the foyer while the Ball Room was prepared for dancing.

Friday, September 26th

The exposition opened at 10:00 a. m. and remained until 10:00 p. m. At 9:30 a. m., a technical session was held in the Ball Room of the Copley Plaza Hotel, Dr. Zay Jeffries presiding. The following papers were presented at this session:

Stainless Iron and Steel—T. Holland Nelson, United Alloy Steel Corporation. (By title.)
Stainless Steel and Stainless Iron—O. K. Parmiter, Firth-Sterling Steel Company. (By title.)
Tensile Properties of Some Steel Wire at Liquid Air Temperatures—W. P. Sykes, National Lamp Works of General Electric Company.
Grain Boundaries in Steel—Cecil H. Desch, England. (By title.)



A FEW OF THE BOOTHS AND EXHIBITS SEEN AT THE EXPOSITION

Macroscopic Examination of Steel—V. O. Homerberg, Massachusetts Institute of Technology.
The Secondary Crystallization in Iron-Carbon Alloys—Dr. Vsevolod N. Krivobok, Carnegie Institute of Technology.
Quenching Properties of Glycerin and Its Water Solutions—Howard Scott, Bureau of Standards.

At 2:30 p. m., the last technical session was held in the Meeting Room on Commonwealth Pier, and consisted of a Symposium on Metallurgical Education, Dr. O. E. Harder presiding. The following papers were presented at this session:

Metallurgical Education—Bradley Stoughton, Lehigh University.
On Metallurgical Education—Dr. S. L. Hoyt, General Electric Company.
Metallurgical Education—Professor D. J. Demorest, Ohio State University.
The Education of the Research Man—Dr. Kotaro Honda, Imperial University, Sendai, Japan.

Plant Visitation

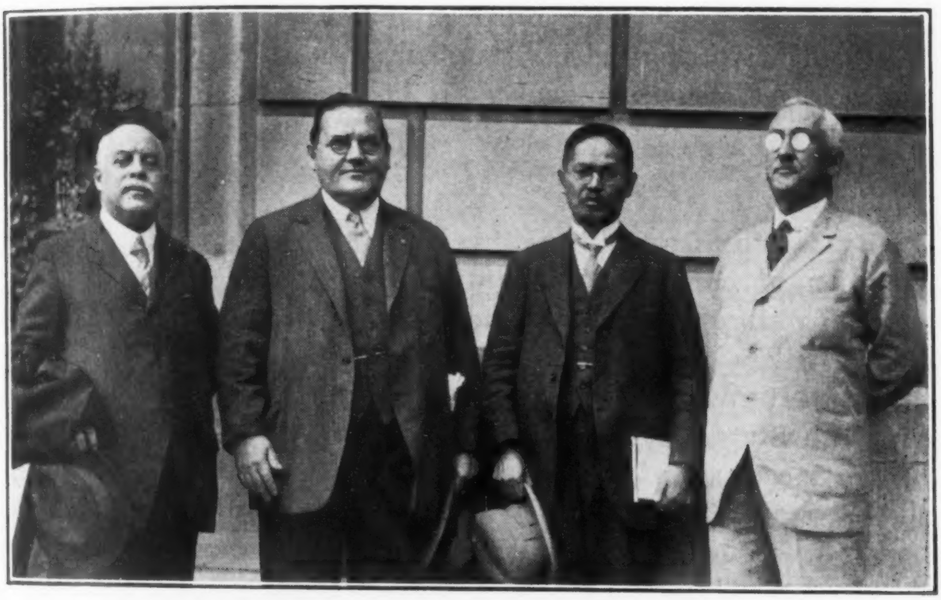
Many members and guests availed themselves of the plant visitation, which was under the direction of Leslie Heath. It had been the endeavor to list plants in order that visitors could get a general survey of important industrial manufacturing conditions in New England. The schedule for Tuesday included an optional trip to the factory of the Thomas G. Plant Company, one of the largest shoe manufacturing concerns in New England, or a visit to Harvard University and Massachusetts Institute of Technology. On Wednesday, the program provided for an inspection of either the General Electric Company's plant at Lynn or a visit to the Naumkeag Manufacturing Co., Salem, a large textile mill. The trip on Friday consisted of a tour of inspection of the Charleston Navy Yard. All of these trips were well attended and proved of intense interest to those who had the privilege of going.

Ladies' Entertainment

The visiting ladies were royally entertained by the Boston Entertainment committee, under the chairmanship of W. W. Cummings, and the ladies' auxiliary committee, and they enjoyed many hours of sight-seeing in and around Boston. The ladies regis-

tered immediately upon their arrival in Boston, headquarters being in Parlor "A" on the lobby floor of the Copley Plaza Hotel. The first activity was a luncheon on Monday at 1:00 P. M., and at 3:00 P. M. they took a sightseeing tour around the city. At 2:30 on Tuesday they went on a shopping tour, after which they had tea. On Tuesday evening, the ladies were entertained at a theatre party. On Wednesday afternoon an excursion to Concord and Lexington was arranged. At 1:00 P. M. on Thursday a boat trip around Boston Harbor was scheduled, after which tea was served on the Pier; in the evening the ladies attended the annual banquet of the Society held at the Copley Plaza Hotel.

From all reports the ladies had a most enjoyable time throughout the week.



HONORARY MEMBERS OF THE SOCIETY

Dr. G. K. Burgess Dr. J. A. Mathews Dr. Kotaro Honda Prof. E. D. Campbell

THE PRESIDENT'S ANNUAL ADDRESS

GEORGE KIMBALL BURGESS

The Constitution of our Society states that the President "shall at the annual meeting, on behalf of himself and on behalf of the Board of Directors, make an annual report to the members of the business and affairs of the Society." The necessity of going into minute detail with respect to the activities of the Board is somewhat lessened by the decision of the Board, made at its meeting, November 2nd, last, to publish in TRANSACTIONS, digests of the Board meetings.

The Board has held three meetings since the last annual convention, one at Washington, November 2, 1923, another at Rochester, January 31, and the third at Moline, May 22, 1924, digests of which have appeared in TRANSACTIONS. A Board Meeting was also held in Boston, September 21, 1924.

The New Constitution

By far the most outstanding event of the year has been the adoption of our new Constitution, under which we have been operating since the announcement by the Secretary of the count by the tellers on March 29, 1924, as published in the May issue of TRANSACTIONS. You will recall that under the laws of Ohio, in which State the Society is incorporated, a $\frac{2}{3}$ affirmative vote of the membership was required. Fifty-three votes more than the necessary $\frac{2}{3}$ were cast in the affirmative, with only 12 negative votes—a most remarkable accomplishment from such a widely scattered membership, reflecting most creditably upon the splendid, constructive work done by the Committee on Constitution and By-Laws, under the able leadership of Mr. S. M. Havens. It is not necessary to dwell at length upon the differences between the old and the new; we have to forget the old and proceed under the new. It might be pointed out, however, that the method of electing officers has been radically changed, provision being made for a larger and geographically more representative nominating committee. Another change that seriously concerns your present officers provides that they hold over for three months, or until December 31, 1924, to make the Society's year coincide with the

calendar year. Several other changes, such as the number of sustaining members permitted to a Chapter, were required by the laws of Ohio. I firmly believe we now have a Constitution satisfactory to the membership and one that meets all legal requirements.

Relations with Other Societies

Our relations with other technical societies have continued to be most cordial and there have been a considerable number of joint activities in which our membership has participated, such as the Cleveland symposium, last May, on metals at high temperatures, and another at Atlantic City, in June, on corrosion, heat and electric resisting alloys. There are also nine cooperative committees forming liaisons with other national organizations (TRANSACTIONS, August, 1924, page 29). The Society has been represented at several anniversary meetings, including the Franklin Institute, Purdue University and Rensselaer Polytechnic.

Standing Committees

The standing committees of the Society have all been aggressively active and have been doing excellent work for the Society. Several of them have been reorganized. At the suggestion of its chairman, the Library Committee was abolished, as was also the Committee on Research, after a careful survey of the situation by a special committee. The monumental work of the Constitution and By-Laws Committee has been mentioned. The Society is greatly indebted to this group for their contribution to the stability of the Society. The Standards Committee has become the Recommended Practice Committee and has been reorganized under the chairmanship of Mr. J. Fletcher Harper, and, with its several sub-committees, has been carrying out an elaborate technical program, which is of great usefulness and far-reaching importance to the membership. The Board of Directors at the November meeting made provision for a technical secretary to assist this and other committees, and the resulting output has fully justified the timely action of the creation of this position, which is ably filled by Mr. J. E. Donnellan.

Mention should be made of the beginning of publication of the American Society for Steel Treating Handbook, the first

sheets of which were issued in December, 1923. Data on 17 subjects, covering 116 pages, have been sent out; data on 10 additional subjects are nearly ready, and 17 other projects are under consideration.

The finances of the Society are on a sound basis and, under the general direction of the Board, are ably and conservatively administered by the Finance Committee, under the chairmanship of the Treasurer, Dr. Zay Jeffries. The Society is to be congratulated on its healthy financial status, as shown in the Treasurer's report.

The Meetings and Papers Committee, as well as the Publication Committee, have been very successful in bringing out new material, improving the standing and consequent recognition of the TRANSACTIONS and stimulating interest in our meetings. The results of the work of these two committees may be said to speak for themselves.

It is of interest to note that our membership is still increasing, showing an ever expanding interest in the work of the Society and demonstrating that we have not reached the saturation point. Our growth has been rapid and, I believe, it has been healthy. The results obtained this year, a net increase of 280, or 10.2 per cent, bringing the total to 3,026, are largely due to the efforts of the Membership Committees of the various Chapters.

Meetings of the Society

The number of Society meetings, including Chapter meetings, reaches the impressive total of 263, with an average attendance of about 100. This indicates a remarkable, sustained and widespread interest in the technical matters, with which our Society is concerned. One new Chapter was added, the "Golden Gate," which already gives promise of coming well up to the standard set by the most progressive Chapters, which now number 29. Two sectional meetings, one at Rochester and the other at Tri Cities, were held; both were well attended and the papers presented were, for the most part, of a high order. The last Annual Convention at Pittsburgh, with its attendant exposition, was a great success from every point of view, technical, educational and social, and it is worthy of note that over one-half the membership was present, and the exhibits, one-half larger than the preceding year, were visited by over 40,000 people.

Your President this year has not been able to follow the strenu-

ous pace set by his predecessors and visit most of the Chapters. His regret in this respect is tempered by the feeling that the Society has not suffered. On the contrary, the American Society for Steel Treating has never been in a more sound, vigorous, healthy condition, free from misunderstandings and geographical jealousies, than now.

The A. S. S. T.

Our organization is democratic, admitting to its membership all interested in technical matters with which the Society treats. It is based on local self-government and initiative of local technical sessions of the 29 Chapters scattered throughout the industrial centers of this country and Canada; cemented by regional or sectional meetings, bringing larger groups together, with an annual convention and international exposition of great educational value, affording opportunity for the membership to meet in a common forum for the discussion of technical problems and make each other's acquaintance; and administered by a small, devoted Board of Directors, with able standing committees and a wonderfully competent headquarters staff under an unexcelled secretary, Mr. W. H. Eisenman, whose sole watchword is service to the Society and community.

The Society is performing a great service to its membership, to the steel industry, to the nation and to the world, in the elimination of wasteful methods in production, affording instruction in improved practices, disseminating valuable scientific and technical information, and stimulating the production and publishing new and valuable contributions to our knowledge of the properties of steel and allied products.

REPORT OF THE TREASURER

ZAY JEFFRIES

The unaudited profit and loss statement of the American Society for Steel Treating from January 1st to June 30th, 1924, inclusive, and the balance sheet as of June 30, 1924, have been published in the September number of TRANSACTIONS on page 217. The report shows that the income of the Society during the first six months of this year was \$35,438.80, and the expenses were \$32,080.56, leaving an excess of income over expense of \$3,358.24.

These figures are exclusive of convention income. The assets as of June 30, 1924, are $66,362.63.

The following comparisons with previous years may be of interest:

AMOUNT PAID TO CHAPTERS	
For 1921	$ 7,244.22
1922	10,051.95
1923	12,751.45
First six months of 1924	8,237.32

TOTAL ASSETS OF THE A. S. S. T.	
As of Dec. 31, 1921	$16,520.96
Dec. 31, 1922	31,391.31
Dec. 31, 1923	46,821.30
First six months of 1924	66,362.63

The assets of the Society are increasing at a rate of approximately $15,000.00 per year. By far the greater part of this increase is due to the convention. It is significant, however, that the Society shows an excess of income over expense on its activities other than the convention.

While the profits from this year's convention are not included in the profit and loss statement for the first six months of 1924, $15,191.25 of the total assets, as of June 30, 1924, represent advance receipts from the present convention.

The President, Secretary and Board of Directors are endeavoring to keep the Society in a healthy financial condition and at the same time render a maximum of service to the members. In the published statement it will be noted that in the first six months of 1924, $4,778.00 were spent in connection with the activities of the Recommended Practice Committee, including the salary of Mr. Donnellan and expenses in connection with the printing and distribution of data sheets.

Nothing can be said at this time definitely regarding the profits from the present convention, but conservative estimates indicate that the profit will be at least as large as that of last year's convention.

The present financial condition and future prospects of the Society are such that additional service to members can be confidently expected. This healthy condition of the Society is due in no small measure to our able secretary, W. H. Eisenman.

ANNUAL REPORT OF THE SECRETARY

W. H. EISENMAN

The A. S. S. T., from September, 1923, to September, 1924, continues its auspicious and successful career. The secretary reported last year the excellent progress made in 1922-23, and submits the present report which, by comparison, exceeds the very creditable showing made at that time.

While the report of the treasurer is listened to with a great degree of satisfaction and a glowing pride in the splendid financial condition of the Society, there undoubtedly comes to all of the members a distinctive feeling that in the work of the year the Society will be judged by its accomplishments in other lines of action than financial. All realize that it's finance that "makes the wheels go round," yet few are so mercenary as to judge success by the dollars and cents that may be added to the reserve. If such a dollar and cent standard was in effect, the A. S. S. T. would maintain its usual high rating for this year, but it is a pleasurable pride to feel that your Society can be favorably judged by its services to the members and the iron and steel industries, in addition to its increasing favorable financial position.

Service to members should be the merit sign of any technical and educational organization and the degree of fidelity in which this worthy aim is followed represents the exact measurement of permanency and attainment. It is needless to add, therefore, that service has been the guiding star of this Society and marks the stepping stones for its humble beginning four years ago to national prominence and success today. When service to members takes second place to other Society activities, that time then marks the beginning of decadence and final obliteration. It was with a view to increased service that your Board of Directors, at a meeting a year ago, went on record to the effect that it was their opinion that the financial position of the Society was in such a sound and substantial condition, that it should be the policy of the directorate to increase the scope of service to the membership to the extent of the current revenue. In other words, in place of making large additions to the reserve, as had been done in the past, the present reserve should be held intact, but current revenue should be expended for increased services.

With this purpose in mind, the directors authorized the employment of J. Edward Donnellan of Cobalt, Conn., to act as secretary to the Recommended Practice Committee and other national committees, to the extent that the problem of collecting and tabulating data and information for the various committees in the preparation of their reports might not prove an added burden on the committee members themselves. With this collecting and tabulating of data, as per their instructions, the committee members could then use their time for sifting and formulating reports. The work of the national committees and subcommittees is a veritable mine of valuable information and assistance to the membership, and so in encouraging this work by assistance from national headquarters in the collecting of material, and by payment of expenses of members of national committees incurred by their attendance at regularly called meetings, the Directors feel they have made progress in the proper direction.

In a further effort to extend greater service to the membership the directors gave the "go ahead" on the preparation and issuance of data sheets for the A. S. S. T. Handbook. This work is under the approval of the Recommended Practice Committee and is a part of Mr. Donnellan's activities. The subject of data sheets will be dealt with more fully later in this report.

These two items—national committees and data sheets—have cost up to September 1, 1924, $5,453.09, an increase of $3,930.61 over last year.

Meetings

Two sectional meetings were held during the year, the first on January 31 and February 1, 1924, in Rochester. The technical papers presented were of high standard and proved very profitable to those in attendance, as well as to the entire membership by later publication in the TRANSACTIONS. The second sectional meeting was held under the auspices of the Tri City chapter on May 22nd and 23rd. Here again the program proved of much benefit, and the large number in attendance showed the increased interest that is being aroused by these events.

The Annual Convention was held in Pittsburgh during the week of October 7, 1923. 1,475 members of the Society registered, which was 53.6 per cent of the entire membership. They were rewarded by one of the best technical sessions ever held under

the auspices of the Society. The attendance at these sessions was from four to seven hundred. The great interest shown by those in attendance in listening to and participating in the discussions aroused quite favorable comment. The Annual Exposition was much larger than any held heretofore. From a standpoint of number and educational value of the various exhibits it contributed materially to the profitableness of the week for all those in attendance. Some 55,000 people availed themselves of the exceptional opportunity to visit the exhibit of metal working and metal treating equipment.

The 28 chapters of the Society have had their number increased by the addition of a chapter in the San Francisco district, under the name of the Golden Gate chapter. All of the chapters have been active during the last year, and have continued the work they are so ably carrying on. They have experienced little difficulty in securing speakers of prominence to address their meetings, and their activities and influences have constantly increased. The total attendance at chapter meetings during the past year was approximately 28,000. There were held in the neighborhood of 275 meetings. The financial condition of the chapters is very encouraging, as shown by the financial statements submitted by the chapter treasurers to the Board at the close of their year's activities in June. The lowest amount in the treasury of any chapter was $175.00, while the largest was about $2,500.00.

Several chapters have carried on educational courses during the year, some under the chapter's auspices, and others in cooperation with educational institutions. This activity is worthy of the highest commendation and certainly increases the prestige of the A. S. S. T. in no small degree.

Membership

There are at present in the American Society for Steel Treating, 3,026 members, of which 2,224, or 73.5 per cent, are of member classification; 476, or 15.8 per cent, are associate. 209, or 6.9 per cent, represent sustaining members, while 109, or 3.6 per cent, are junior members. There are 6 honorary members, and 2 founder members.

Membership in the Society during the period from September, 1923, to August, 31, 1924, shows a net gain of 10.2 per cent.

On September 1 of last year there were 2,746 members. During the year there has been a net gain of 280 members, so that the total membership today of bona fide paid up members is 3,026. The gain in members this year is slightly less than the percentage of gain for 1922-23. It should be borne in mind, however, that last year the Society and chapters were working under the stimuli of cash prizes for increased membership. It can be stated that the percentage of gain for this year represents a healthy, normal and gradual growth of the Society.

There are about 400 members of the Society serving on various technical and administrative committees in the preparation of recommended practices, reports, professional papers, meetings and the dissemination of literature for the advancement of the metallurgical profession and the steel industry. Of this number, about one-half are on national committees, and one-half are serving on local committees. The men serving on the local and national committees are entitled to and receive the fullest commendation for their valuable contributions to the work of the Society.

Publications

TRANSACTIONS:- Following the announcement made at the Convention last year, the amount of material published in TRANSACTIONS during a period of 12 months was too large for binding into a single volume, and it was, consequently, necessary to issue TRANSACTIONS in two volumes a year. The dates were changed so that the volumes begin with January and July. Volume V was complete with the June, 1924, issue, and contained 642 pages for the 6 issues. Already 438 pages have been published of Volume VI. It has been the constant endeavor of all those connected with the organization to make TRANSACTIONS of greater value and permanence, and while it has not yet reached a point where self-satisfaction expresses itself, nevertheless from the various reports and commendatory letters that have been received, one is led to feel that TRANSACTIONS is constantly improving. The membership has undoubtedly noted that, beginning with the July issue this year, TRANSACTIONS is being sent out as a sewed book. The advantage of this is apparent to all, as the book now opens and lies flat. This added expense is justified in the increased ease with which the magazine can be handled and read, and that it

allows a wider margin and a better appearing type page.

During the four years TRANSACTIONS have been issued, there have been published 4,910 pages of editorial matter of interest to the members, or an average of 1,255 pages per year. The editorial pages of the volume issued to date are as follows:

Volume I— 840 pages
Volume II—1,238 pages
Volume III—1,000 pages
Volume IV— 752 pages
Volume V— 642 pages
Volume VI— 438 pages
(three numbers, including September, volume not complete).

Since January 1, 1924, there have been issued 1,080 pages of editorial matter, and there are three numbers yet to be published for Volume VI, so a conservative estimate is that a total of 1,400 pages will be issued during the year.

It has been the endeavor of the Meeting and Papers Committee to secure, at as early a date as possible, papers that are to be presented at the Convention, in order that they might be preprinted in TRANSACTIONS, and copies made available for distribution at the Convention, thus allowing time for preparation of written discussions. Quite some difficulty has been experienced in getting papers at an early date. However, the committee has been more successful this year, and so far there have been preprinted 16, or 50 per cent, of the Convention papers.

It seems but proper in detailing the activities of TRANSACTIONS that one should express here a note of appreciation to the advertisers who have so loyally supported the Society's activities during the past year. It is possible that the membership, as a whole, does not realize that the firms using the advertising pages in TRANSACTIONS contribute nearly $22,000 each year toward the activities of the Society. This is no small item and represents a large percentage of the gross receipts of income. Consequently, it is strongly urged that the members show their appreciation of this support by a reciprocal relationship wherever possible to those firms who are assisting the Society.

Further appreciation is voiced to those contributors of articles to TRANSACTIONS who have given so liberally of their time and information for the benefit of all. When it is realized that there are no paid articles in TRANSACTIONS, that everything published therein is material that has been presented before the annual conventions, sectional and chapter meetings, or contributed at the request of the editor, it is discernible that a spirit of selfishness has no part in the make-up of the A. S. S. T. membership. The membership, as a whole, is duly appreciative of these valuable contributions to the furtherance of the aims and objects for which the Society stands.

DATA SHEETS: As was detailed in the secretary's report last year, preparation was being made for the publication of the A. S. S. T. Handbook, and while some material had been collected, none had been published or forwarded to the members. The first issue of data sheets was forwarded to the members in December, 1923, and additional sheets have been forwarded monthly since that time.

The members have now received data sheets on seventeen different subjects, including 116 pages, as follows:

1.	Nitrogen in Steel	2 pages
2.	Melting Points of Chemical Elements	1 page
3.	Fusing Points of Seger Cones	1 page
4.	Decimal and metric equivalents of parts of an inch	4 pages
5.	Specific heat of air	4 pages
6.	Weights of steel bars	8 pages
7.	Tungsten as an alloying element in steel	4 pages
8.	Recommended practice in the heat treatment of 18 per cent tungsten high speed steel	2 pages
9.	Recommended practice in the heat treatment of plain carbon tool steel	4 pages
10.	Pyrometry	15 pages
11.	Preparation of metallographic specimens	4 pages
12.	Etching solutions for iron and steel and structures revealed by each	16 pages
13.	Brinell hardness tests	2 pages
14.	Standardized clay fire brick shapes	10 pages

15.	Tables for turning circles of various diameters with standard fire brick shapes	10 pages
16.	Lead baths	15 pages
17.	Iron-carbon diagram	14 pages
		116 pages

The following sheets have been printed but not yet issued to the members:

1. Temperature conversion table
2. Scleroscope hardness tests
3. Rockwell hardness tests

The following data sheets have been approved by the Recommended Practice Committee for publication:

1. Percentage of Reduction of Area of .504″, .505″ and .506″ diameter test specimens
2. Stainless steel
3. Heat losses through furnace walls

The following data sheets have been reviewed by five members of the Society and are now being considered by the Recommended Practice Committee:

1. Nickel steels
2. Photomicrography
3. Iron and Steel Chemistry

Authors have agreed to prepare data sheets on the following subjects:

1. Influence of Vanadium as an alloying element in steel
2. Influence of Chromium as an alloying element in steel
3. Influence of Molybdenum as an alloying element in steel

4. Gases in metals
5. Deep etching
6. Strength of steels at higher temperature
7. Cutting tests on high speed steel
8. Table for carburizing and heat treatment of carburized steels
9. Principles of quenching
10. Melting points of various constituents found in steel
11. Corrosion of iron and steel
12. Forging steel
13. Heat treatment and hardening of steels for permanent magnets
14. Heat treatment of ball bearing steels
15. Process of pickling steel and the brittleness encountered
16. Wire drawing data
17. Hardness data after tempering various grades of steel

Special Services

Special services the Society is able to offer continues to show an increase in usefulness, and more and more people every year are availing themselves of the opportunity to secure reprints and photostatic copies of articles that may be of value to them, and there has been also a greatly increased use of the facilities of the national office for placing members in touch with occupational vacancies as they occur. Some 400 members have had their loose copies of TRANSACTIONS bound at cost by the national office.

The publication of data sheets and the various other activities of the Society have increased the mail matter that is forwarded from the national office to a great degree. At the present time, it amounts to nearly 200,000 pieces during the year.

The present Convention and Exposition speak for themselves. The exhibit is 30 per cent larger than any we have previously held and gives every indication of being as successful financially as the previous shows.

The Board of Directors has decided to hold the 1925 Convention in the Public Auditorium at Cleveland, where the fine facili-

ties of that building will be made available during the week of September 14 to 18.

Four years of fruitful activities are behind us, but the four-score years of the future open to all a wonderful vista of possible splendid and successful achievements. The invaluable services of your Directors of the past and present, to whom we owe so much for the firm foundation upon which we are builded, will unquestionably be paralleled by the Directors of the future, so that the principles of progress and service will continue to be the guiding spirit of the A. S. S. T. and lead it on to higher planes of usefulness.

WINTER SECTIONAL MEETING

THE winter sectional meeting will be held under the auspices of the Cincinnati chapter of the Society, the dates for this meeting being Thursday and Friday, January 15 and 16, 1925. A comprehensive technical program has been scheduled for Thursday morning and afternoon, and in the evening the usual banquet will be held. Friday will be devoted to plant visiting. An invitation to attend the sectional meeting in the Queen City is extended to all. Further details of this meeting will be published later.

UNAUDITED PROFIT & LOSS STATEMENT
AMERICAN SOCIETY FOR STEEL TREATING

From January 1 to September 30, 1924

INCOME

Dues (Gross)	$25.116.08	
Transactions Advertising	21,481.80	
Transactions Sales	1,321.50	
Bindery Account	751.00	
Discounts Received	204.80	
Interest	880.49	
Data Sheets	1,374.20	
Miscellaneous Receipts	614.17	$51,744.04

EXPENSES

Discounts Allowed	$ 155.29	
Bindery Account	846.90	
Reprints	157.23	
Data Sheets	3,124.92	
Library	77.16	
Miscellaneous Expenses	464.37	
Transactions	18,126.84	
Secretary's Office	7,452.02	
President's Office	73.00	
Treasurer's Office	1,373.02	
Director's Expenses	1,273.34	
National Committees	3,086.23	
Sectional Meetings	620.88	
Increase of Membership	22.53	
Local Chapters	10,338.20	$47,191.93
Excess of Income over Expense		$ 4,552.11

BALANCE SHEET

ASSETS

Commercial Account Cleveland Trust Co.	$ 2,480.14	
Savings Account Cleveland Trust Co.	5,000.00	
Savings Account Equity Savings & Loan Co.	16,052.74	
Savings Account Union Trust Co.	1,104.06	
Bond Investments	31,000.00	
U. S. Treasury Certificates	2,015.00	
Accounts Receivable for Advertising	5,547.05	
Accounts Receivable Miscellaneous	3,294.04	
Office Furniture and Fixtures	1,052.44	
1923 Convention Accounts Receivable	470.22	
1924 Convention Prepaid Expenses	24,508.74	
1925 Convention Prepaid Expenses	300.25	
Inventory Jan. 1, 1924	2,119.48	$94,944.16

LIABILITIES

Accounts Payable		$ 869.52	
Reserve for Dues Paid in Advance		10,000.00	
Reserve for Doubtful Accounts		1,000.00	
Permanent Convention Reserve		20,000.00	
Advance Receipts 1924 Convention		42,850.50	
H. M. Howe Medal Fund		3,000.00	
Surplus, January 1st, 1924	$12,672.03		
Profit from Jan. 1st to Sept. 30th, 1924	4,552.11	17,224.14	$94,944.16

X-RAY TESTS APPLIED TO THE PROBLEMS OF THE STEEL FOUNDRY

By H. H. Lester

Abstract

X-ray tests with collateral analyses indicate that defects in steel castings fall into a relatively few classes traceable to definite and simple causes most or all of which are removable. When defects are detected by X-ray examination and corrected by changing casting technique, they tend to stay corrected. It is possible by this method to eliminate from 75 to 90 per cent of the major defects in steel castings.

Metal sections up to 3 inches in thickness may be examined. Where the value of the product warrants it, X-rays may be used to test each individual casting. In other cases casting technique may be developed that will produce sound castings.

During the last few years there has been a growing interest in the possible application of X-rays to the practical solution of problems confronting the metallurgist. Such men as Westgren, Jefferies, Archer, Hull, Davey, Bain, McKeehan and several others have made considerable use of X-ray experimentation to get at fundamental structures in metals. Their contributions have given us a much better understanding of the nature and constitution of iron and its alloys than we have had heretofore. The present paper is intended to illustrate a much simpler application of X-rays to metal problems, but at least one of not less practical importance. This application is the use of X-rays to photograph defects in metal castings to the end that those defects may be removed. The idea of using X-rays for the purpose of photographing defects in metal is not new. It was used during the world war in Germany, England, and by the General Electric Co. in this country with good results.* It was used, however, more as a method for inspection testing for the purpose of identifying material unfit for service, the defects in which could not be discovered as easily by other

*The best early paper on this subject was presented by Dr. W. P. Davey in *The General Electric Review*, Jan., 1915. His results were limited by the fact that modern high power equipment had not been developed at that time.

A paper presented before the Boston Convention of the Society, September, 1924. The author, Dr. H. H. Lester, is Research Physicist at Watertown Arsenal, Watertown, Mass.

methods. Its value for this work is unquestioned. The X-ray identifies defects that are beneath the skin of the metal and that very often give no surface indications of their presence. Fig. 1 illustrates this point. This picture shows a section through a casting that had passed inspection and had been accepted for service. It was supposed to be a good casting, yet there are numerous defects, very few of which could have been detected by ordinary testing methods. This casting is by no means unusual. It is representative probably of 20 per cent of commercial steel castings.

The United States Ordnance Department has made some use of the X-ray method of inspection. It has, however, added an idea in that it is considered more practical to get good castings by studying casting defects, so that those defects may be removed, rather than that castings may be rejected. To this end defects in steel castings have been studied, analyzed, classified and where possible correlated with fundamental causes. The study has not been confined to ordnance castings. Commercial concerns, both producers and consumers, have been invited to send in their troublesome castings for study. They have done so to an extent that during the past year fully 30 per cent of the castings tested have been made by commercial concerns. This fact has given the results obtained a wider practical application. Also because of this fact the Ordnance Department feels an obligation to put the results before the public, in the hope that the metal industry in general may be benefited. The results of one of the series of tests for a commercial concern have been published recently.[1] Some illustrations in the present paper are taken from this study.

Methods of Testing

Castings are received in the X-ray laboratory and are marked off into areas through which pictures are desired. Vital sections are covered much more completely than sections of less importance. The pictures vary in size, depending on the contour of the casting, up to 14 by 17 inches. In one series of castings recently tested the average sized area covered in a single picture was approximately 64 square inches, the area of an average casting covered was 63 per cent of the total, and it was estimated that around 40 per cent

[1] "Using X-Rays to Detect Hidden Dangers in Plant Equipment." By H. H. Lester, F. C. Herthel, William Mendius, and William V. Ischie. Chem. and Met. Eng., Oct 20, 1924.

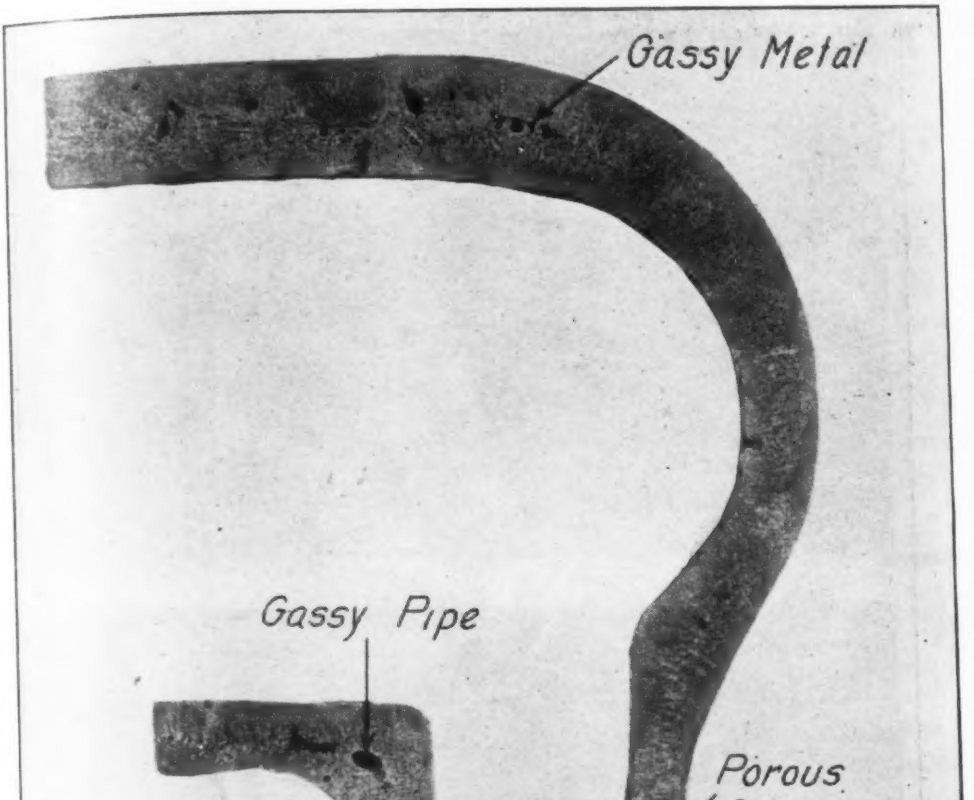


Fig. 1—Section of a Commercial Steel Casting Showing Numerous Types of Defects which may occur in such Steel Castings.

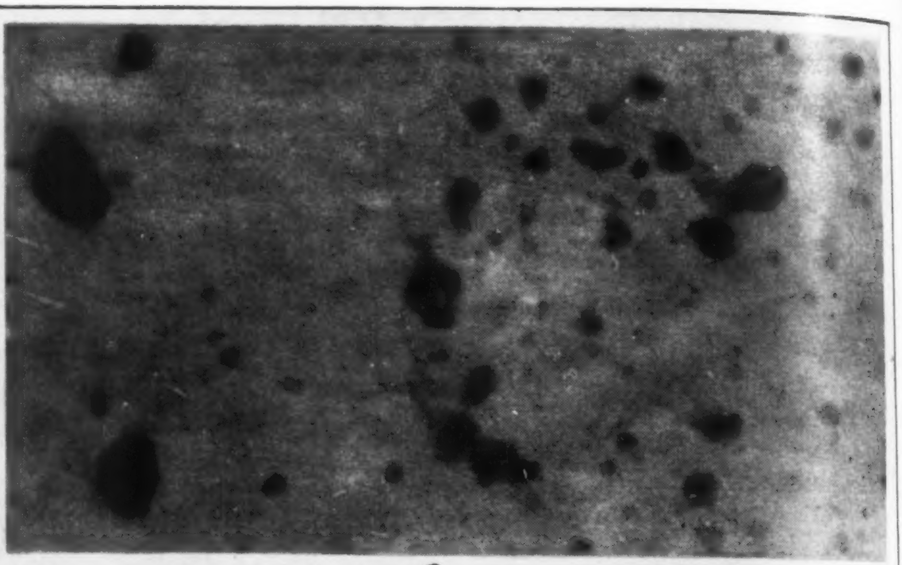


Fig. 2—Radiograph of a Steel Casting Showing Gas Pockets Caused by Dirt Trapped in Mold. Fig. 3—Radiograph of Steel Casting Showing Dirt and Gas Trapped in Horizontal Cope Section where there was No Flow of Metal toward the Riser. The Dark Areas are either Voids or Inclusions and are Negative Reproductions of the Original Film, that is, they are not Positive Prints from the Original Radiographic Film. All of the Radiographs Accompanying this Paper are Negative.

of the total metal volume was radiographed. Where additional information is sought over that afforded by the X-ray pictures the castings are cut through some of the defects. In cutting it is usual to use a double saw and to take out a 1/4-inch cross sectional piece. This strip is surface ground, radiographed, and macro-

etched. Revealed defects are studied carefully and inclusions are picked out and analyzed. The macroetch develops fine cavities, cracks, segregations, and differences in metal texture.

Defects Found

About 600 castings are represented in the present study. Of these approximately 100 have been from commercial foundries located in different parts of the country. Both electric and open hearth steel are represented and all castings considered are plain carbon steel, the carbon ranging from 0.18 to 0.35 per cent.

In some cases the same castings made in different foundries are represented and in several cases the same casting made under different conditions in the same foundry. The defects found have fallen into a relatively few distinct types traceable to a relatively few simple causes, most or all of which are removable. These defects are given below classified according to their causes.

Gas Pockets

The largest number of cavities is caused by gas that gets into the molten metal from various sources. Fig. 2 illustrates gas pockets formed from dirt left in the molds. In this case the cavities were traced back to loose molding sand that carried carbonaceous binder. The binder broke down in the presence of the hot metal, giving CO and free carbon. The holes had bright walls, but contained a black deposit that on analysis proved to be carbon and SiO_2. These holes were found in bell shaped castings 180 degrees from the single gate. The metal flowed in two directions from the gate and dirt was trapped at the place where the two streams reunited. Similar conditions are found very often along the cope, as illustrated in Fig. 3. Here the metal entered a horizontal cope section from two points and there was no flow of metal along the cope towards the riser. Gases and dirt were trapped, giving a region of dirty metal sometimes full of gas pockets. Some of the largest gas cavities found have been in cope sections and apparently due to similar causes.

These pictures emphasize a point that is well enough known, but that is too often neglected, that is, any dirt that gets into the metal is apt to be a source of gas, and this gas may not always escape. The trouble may be avoided at least to a considerable

extent by exercising care in blowing out and in closing molds. Also the gates should be arranged to insure a definite flow of metal in all parts of the casting towards the riser while the mold is being filled, thus giving as much opportunity as possible for sweeping out gas and dirt accumulations.

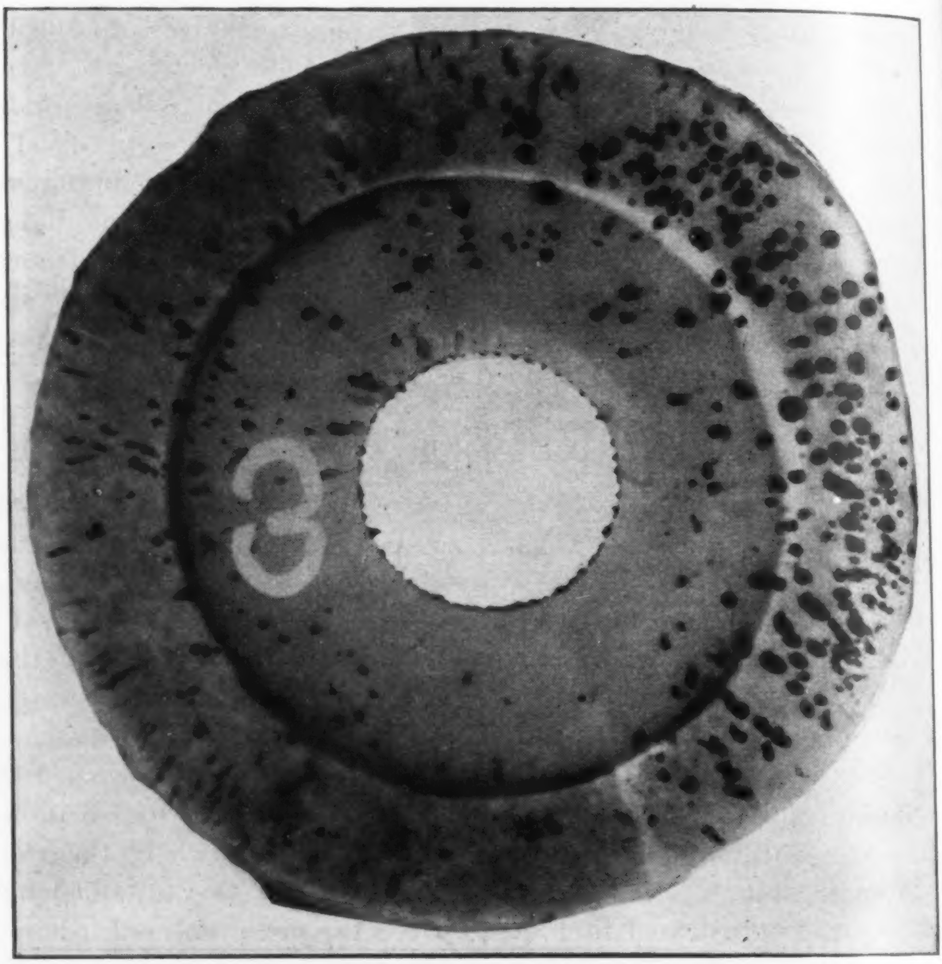


Fig. 4—Radiograph of Steel Casting Illustrating Cavities Caused by Imperfectly Deoxidized Metal. The Light Colored "3" is the Image of the Lead Indicator. The Indicator is Placed on the Opposite Side of the Metal from the Photographic Film, it Serves to Indicate whether the X-rays have Actually Penetrated the Metal, Identifies the Section and Serves as a Point of Reference in Comparing the Negative with the Casting.

Fig. 4 illustrates another type of gas pocket. The walls of the cavities in this case were silvery white. Some of the cavities contained deposits which, on analysis, proved to be about 90 per cent FeO, with a little silica. The metal in the vicinity contained con-

Fig. 5—Photograph of an Etched Section of Steel Casting Showing Spongy Metal at the Center, due to the Presence of Small Gas Bubbles which Exaggerate the Porosity Caused by Capillary Pipes. This Section was taken at Right Angles to the Flow of Metal in the Final Stages of Solidification. It will be Noted that Solid Metal Occurs near the Surfaces of this Casting as Denoted by the White Lines.

siderable dirt which, under the microscope, had the appearance of iron oxide.

Sometimes the particles of FeO or other oxides are very small and bubbles of CO are formed around the particles. These bubbles do not rise through the molten metal. This condition gives rise to a spongy area that, in addition to being a weak place in the metal, may be the cause of leaks in hydrostatic pressure tests. Sometimes the small bubbles coalesce and escape to the more liquid center of the section, collecting in and enlarging pipes and increasing the sponginess of the central part of the section, which is already loose-textured from a different cause. Figs. 1, 5 and 23 illustrate this condition, although in these pictures the source of the gas was only surmised. Very often the CO gas vents to the surface of the casting, giving the pinhole apertures on the surface familiar to every foundryman. These pinholes often extend as elongated cavities resembling worm holes and often terminate at the inner end in enlarged cavities that are sometimes enlarged pipes.

Occasionally gas pockets are caused by damp molds. Fig. 6 illustrates such a case, though in this case the mold was wet, rather than damp. The walls of the cavities were covered with a layer of black oxide. Similar cavities are found in many cases where the castings are made in green sand. It is possible that these green sand cavities are caused by imperfect surface drying, but it seems more probable that insufficient or improper venting of the molds is the primary cause. Gas or steam pressure developed in the sand finds its easiest escape through the metal, rather than through the sand. Fig. 7 illustrates such a case.

Sand Inclusions

The sand and dirt that get into the metal do not always cause gas pockets. Figs. 8, 9 and 10 illustrate sand inclusions that are not accompanied by gas. Fig. 8 is typical of one kind of sand inclusion. Here sand and dirt carried on the surface of the molten metal as it rose in the mold became entangled in a surface crust. This crust caught on a curved surface of the mold, and the more liquid metal rose past it, leaving the sand imbedded in the surface of the casting. A condition similar to this often may be traced all the way up one side of a casting and is similar to the

condition found in the cope, where gases and dirt are trapped because of insufficient velocity of flow towards the riser. The effect of surface inclusions on the life of the casting is illustrated in Fig. 9. This represents a casting taken from service. Pre-

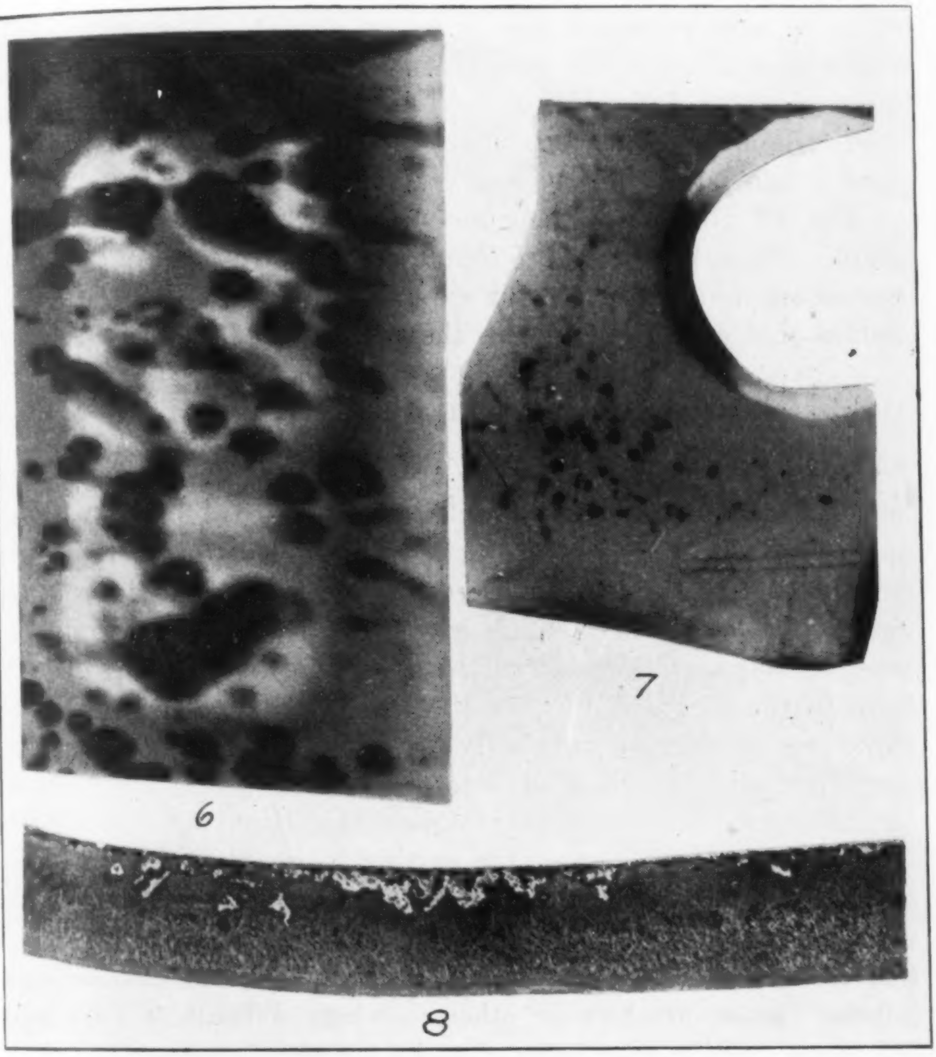


Fig. 6—Radiograph of Steel Casting Showing Cavities due to Steam Injected from a Damp Mold. Fig. 7—Radiograph of Steel Casting Showing Cavities Caused by Steam Injected from a Green Sand Mold. Fig. 8—Photograph of Deeply-Etched Section of Steel Casting Showing Sand Pockets along the Surface of Casting. The White Areas are the Sand Inclusions.

sumably there had been sand pockets in the inner surface, and these eroded rapidly, leaving bad surface cavities. The more serious sand inclusions occur when the runner system or parts of the mold are cut or eroded by the stream of hot metal during

pouring. The abraded material, sometimes as fine particles, but often as large chunks, rises through the central part of the section and frequently is trapped entirely within the metal. Fig. 10 represents scattered inclusions trapped in this way. Figs. 11 and 12 represent a more serious case. Here a portion of the mold seems to have collapsed, due to severe erosion. The casting from which these illustrations were taken weighed 1,400 pounds. It was estimated that fully 15 per cent of the total metal volume was sand, although the surface indications were so slight that the inspector had passed the casting as acceptable for service.

Fig. 13 illustrates a slag inclusion as it appears in the radiograph. These inclusions are found much less frequently than sand inclusions, and, so far as our experience goes, never in the large chunks that often characterize the sand inclusions.

Pipes

The defects considered above are due to foreign matter gaseous or solid that gets into the metal. These may be eliminated more or less completely by proper care in handling the metal or the molds. Fig. 14 illustrates a defect due to the characteristics of the metal. Molten metal occupies more volume than solid, and since freezing starts at the surface there is a tendency for a cavity to form in the region last to solidify. This cavity is called a pipe. Pipes are prevented ordinarily by the use of heads or risers. These are made as integral parts of the casting and are later cut off. They act as reservoirs of liquid metal and are intended to feed metal into the rest of the casting to make up for shrinkage during solidification. The riser should be last to solidify and should contain the pipe. Unfortunately, risers do not always function as intended. Most castings contain thick and thin sections, isolated bosses, brackets or other members difficult to feed from the risers. Chills may be used to hasten the freezing of thick or isolated sections, but even with the greatest care pipes may be formed.

Figs. 15 and 16 illustrate the conditions that caused the pipe shown in Fig. 14. This casting was shaped like a car wheel and was cast in a vertical position, with a riser on the rim, as shown in Fig. 15. Fig. 16 shows a section of the casting with the pipe indicated. This cavity occurs in the center of the thickest portion

of the rim. The web of this casting was of relatively thin cross section, and all parts of it approached the freezing temperature at the same time, and, because of the relatively large exposed surface per unit volume, passed quickly through the freezing range.

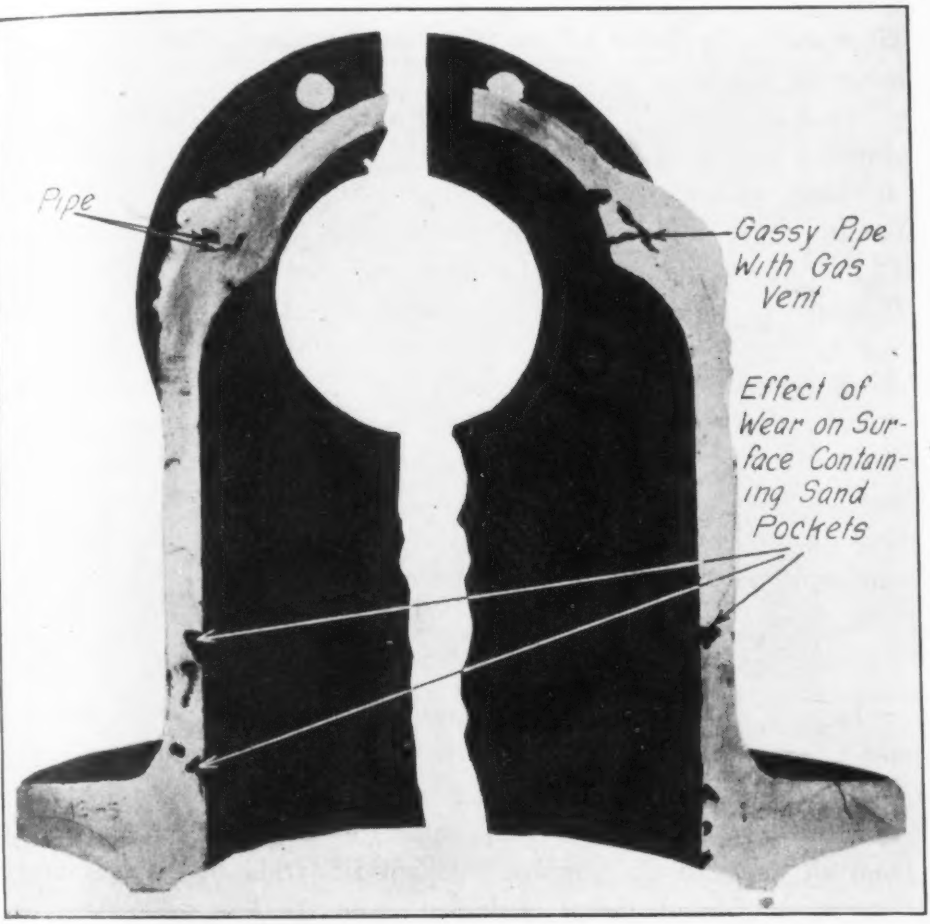


Fig. 9—Photograph of Steel Casting Showing Effect of Wear in Places where Surface Sand Inclusions have Dropped out, Leaving Bad Surface Cavities.

The large shrinkage occurs during solidification. There was in consequence a large and sudden demand on the riser for metal. It would be difficult for a single riser to supply this demand rapidly enough to prevent the formation of a pipe. Cases have been found where the pipe had been formed and had later filled up by subsequent flow from the riser. Fig. 17 shows photographs of etched sections taken from identical castings just beneath the riser. In one case the cavity was nearly, but not quite, completely filled by

subsequent flow. In the other case very little flow occurred. Fig. 18 shows a section across a pipe that had been formed and had subsequently filled up. The etching treatment brings out a distinct difference in the texture of the metal in the pipe and adjacent to it. Fig. 19 is a radiograph taken near the base of a riser. The riser evidently froze off in this case because it had been necked down at the base.

In Figs. 14 to 19 care has been taken to select illustrations from simple castings involving no unusual sections. It is seen that even in these cases the risers frequently fail. The failures are caused for the most part by premature freezing at the base of the riser. This freezing occurs in some cases even with well designed risers. It seems probable that in these cases this trouble may have been due to the fact that the metal was partially chilled while rising through the mold. It is a usual practice to fill the mold till metal shows in the risers. The ladle is then moved and the risers are filled up with fresh hot metal from the ladle. In some cases at least the fresh metal is poured in on a semi-molten crust near the base of the riser, and this crust does not remelt, thus forming a semi-molten plug that acts to prevent feeding.

Capillary Pipes

In the above the pipes discussed are familiar to all foundrymen. Fig. 20 shows a type of piping not so familiar. Freezing is supposed to start at a point remote from the riser and to progress towards the riser. At the same time it is progressing inward from all parts of the surface. As solidification in the remote sections is completed, metal is drawn from the less remote to make up for solidification shrinkage. As adjacent sections are robbed, metal must flow from the riser to supply the deficiency. This secondary flow is progressively impeded as the freezing from the surface restricts the channel through which the metal must move. In cases of large sections of uniform thickness, the channel may become sufficiently constricted that complete feeding in the final stages of solidification may be prevented. There results a region of porous metal in the center of the section. This condition is illustrated in Fig. 20, which shows a radiograph of a portion of the web of the casting illustrated in Fig. 16. The irregular marks represent fine capillary pipes. These pipes occur towards the

center in the region of the thin section last to solidify. Fig. 21 shows a radiograph of a $\frac{1}{4}$-inch cross section through a casting, showing similar markings in the radiographs. This section was taken in the direction of the secondary flow. The cavities were exaggerated in this piece, due to the fact that gas had accumulated

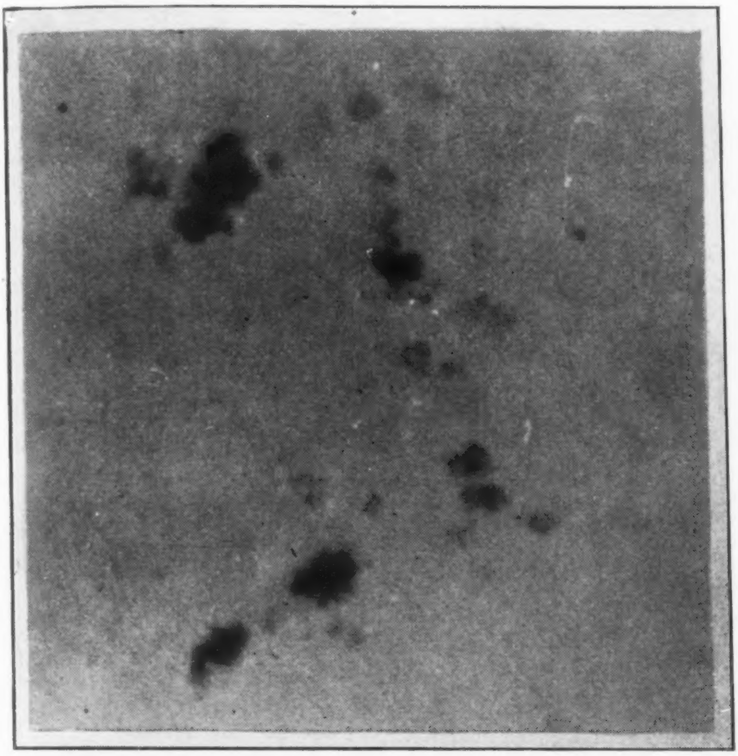


Fig. 10—Radiograph of Steel Casting Showing Scattered Sand Inclusions. The Dark Areas are the Sand Inclusions.

in the porous section and had enlarged the pipes. Figs. 23 and 24 show radiographs of cross sections similarly taken where there were no gas complications. These cavities are developed also by etching, as illustrated in Fig. 22, which is a photograph of an etched section taken in the direction of the secondary flow. In this the metal structure in the center of the section is seen to be considerably broken up. Fig. 25 shows a photograph of an etched section taken at right angles to the direction of the secondary flow. The effect here is exaggerated by the presence of impurities, some of which were gaseous.

The peculiar V-shaped markings illustrated in Figs. 21, 22,

11

12

Fig. 11—Radiograph of Steel Casting Showing Sand Inclusions. Fig. 12—Photograph of Section Taken near Region Shown in Fig. 11. The Dark Mottled Areas are the Sand Inclusions.

23 and 24 have occasioned considerable speculation in the arsenal laboratories. Just what do they mean? The salient facts regarding them gained from a study of about 60 such sections may be summed up as follows:

1. The V's point always toward a region of primary solidification.
2. They may occur in thick sections and may be absent in thin ones.
3. They are cavities in a great many cases and probably in all cases.
4. They do not represent segregations, though it is probable that they contain segregations in some cases.
5. For a given thickness of section the V's are more pronounced and more numerous the greater the secondary flow.
6. For a given secondary flow the V's are more pronounced the thinner the section.
7. For a given section the V's are more acute the greater the flow.
8. Between two regions of primary solidification the V's become less acute, degenerate to straight lines and finally reverse directions.
9. In places between two regions of primary solidification where there has been considerable outward flow from the section, the V's are straightened out and appear to be cavities between dendrites.
10. In other cases the ends of dendrites are bent in the direction towards which the V's point.
11. In many cases where the V's are acute the dendrites are broken and the V's cross the broken dendritic structure.

From a consideration of the above points it seems to the writer that the most probable explanation of the V-shaped markings is somewhat as follows: After the mold is filled and freezing starts, secondary flows are set up towards regions of primary solidification. The large shrinkage in metal occurs during solidification. Where there are large areas remote from the risers that pass rapidly through the solidification range and where the metal to feed these areas must pass through a comparatively small channel, the flow in this channel must be considerable. Molten steel is somewhat viscous at the best and becomes more so as the temperature

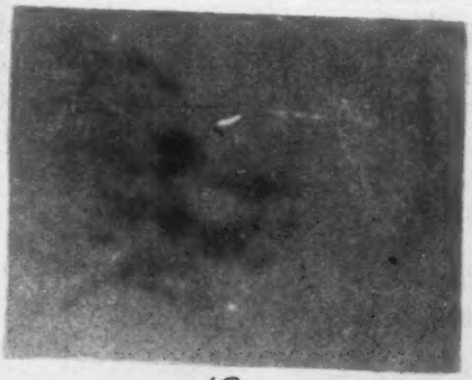


Fig. 13—Radiograph of Steel Casting Showing Slag Inclusions. Fig. 14—Radiograph of Steel Casting Showing Fillet Pipe.

approaches the freezing point. In the end there is a condition where viscuous material is forced through a restricted channel. The result is that the metal is more or less torn apart. The edges

of the flow are retarded and the center presses forward, causing the cavities to assume the characteristic V-shapes. The V's will point always in the direction of the secondary flow. When the metal starts to solidify in any section, slender needles (dendrites) are sent out into the liquid mass. The metal solidifies onto these

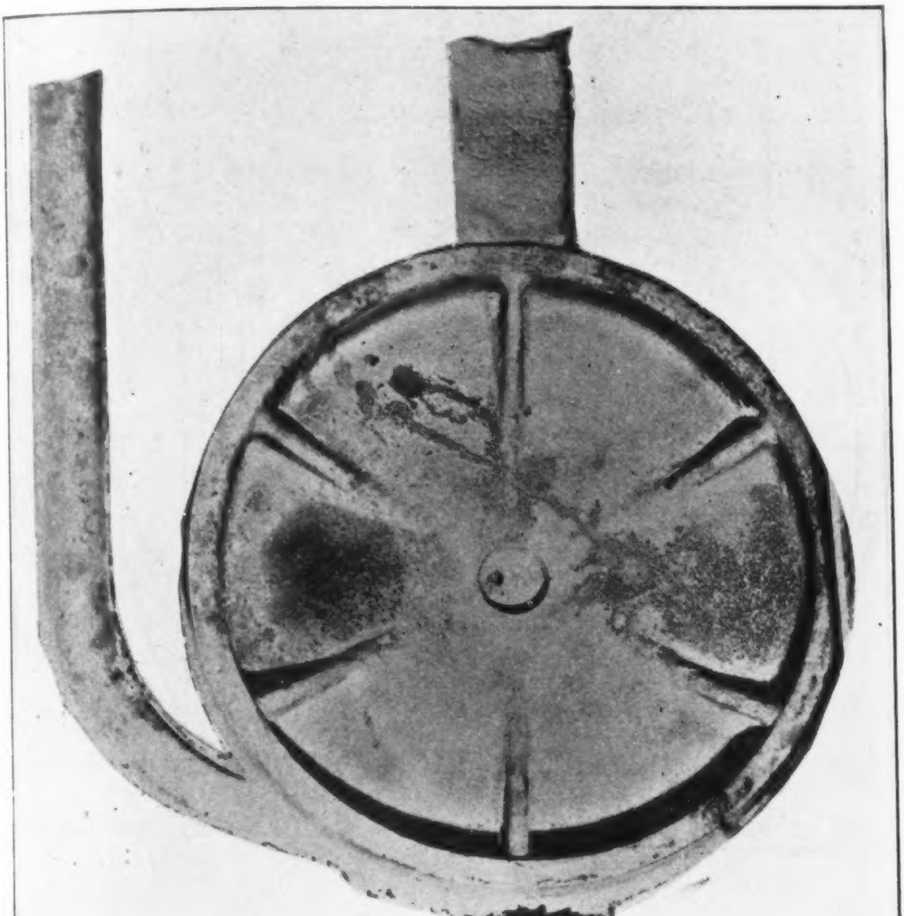


Fig. 15—Photograph of the Steel Casting Illustrated in Figs. 14 and 16.

needles. If there were insufficient metal present there would be a tendency for cavities to form between adjacent dendrites. This does occur in many cases, so that where there is no secondary flow through the section there is a tendency to form loose-textured metal with microscopic cavities between adjacent dendrites. This condition is, in fact, illustrated in parts of Fig. 22, and in the bolt flanges shown in Figs. 18 and 22. Where there is secondary flow,

the ends of the dendritic needles may be bent in the direction of the flow or the dendritic structure may be broken off, with portions of the same dendrites appearing on both sides of the cavity. This condition was found in the negative of Fig. 22, but due to difficulties of reproduction is not easily traced in the print.

Figs. 23 and 24 represent castings made from the same pattern, but one was cast upside down with reference to the other.

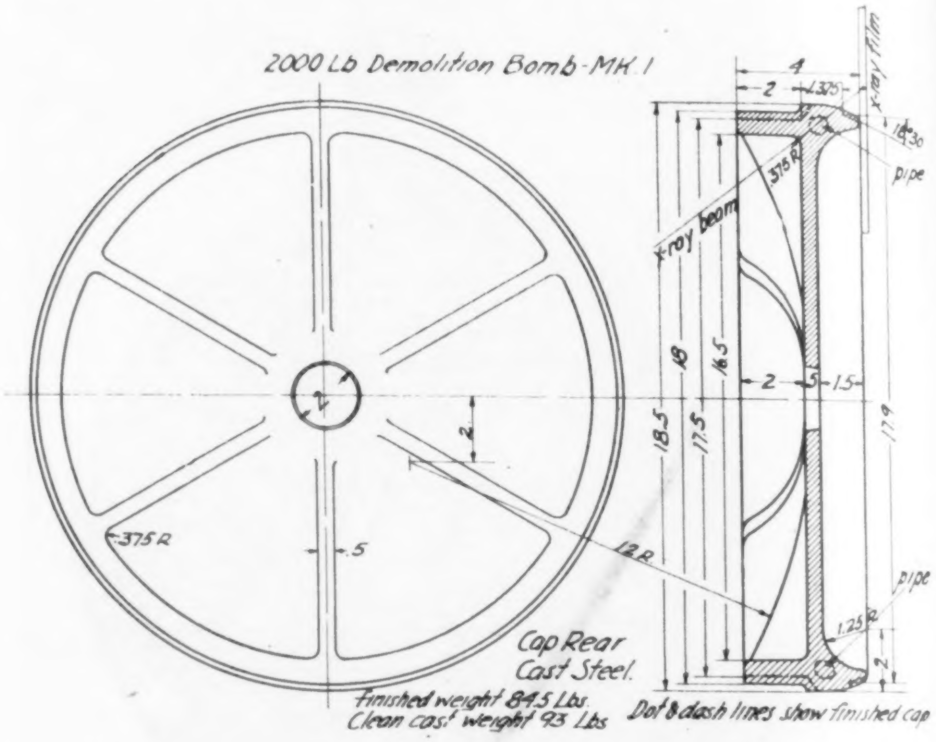


Fig. 16—Drawing of the Steel Casting Shown in Fig. 15, Indicating Method of Taking X-Ray Photographs through the Filleted Section.

The castings were fan-shaped wedges, 6 x ½ inches at one end, 3 x 2 inches at the other, and 30 inches long. They were cast in a vertical position with the riser on top, in each case with the gate placed on one of the thinner edges at the bottom. Figs. 23 and 24 are radiographs of a ¼-inch cross sectional piece of the riser and casting taken through the center of the casting parallel to the vertical axis and at right angles to the broad side. The strip was cut into four parts for convenience in handling. These parts are shown as A, B, C, D. Of these, A represents the section through the riser and B, C and D, in the order named are the

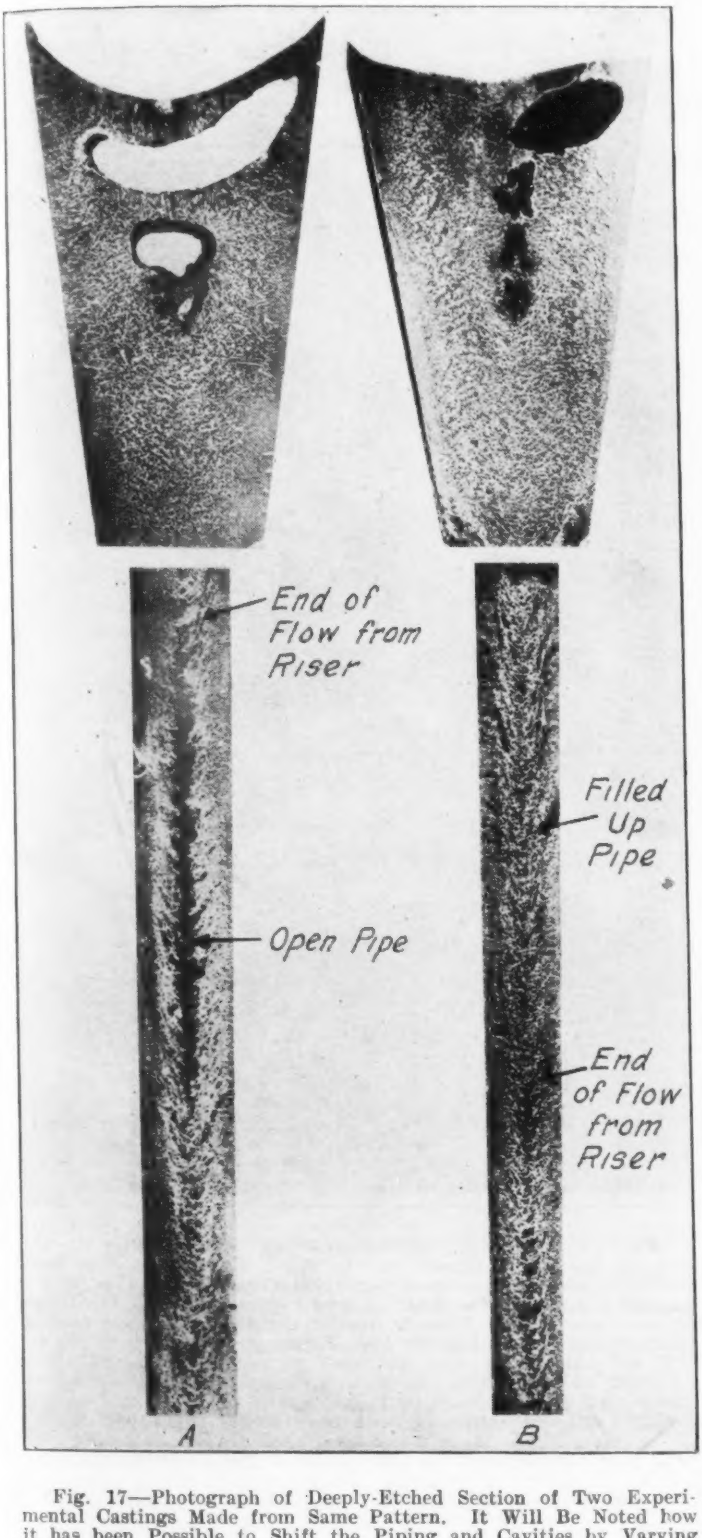


Fig. 17—Photograph of Deeply-Etched Section of Two Experimental Castings Made from Same Pattern. It Will Be Noted how it has been Possible to Shift the Piping and Cavities by Varying the Foundry Practice.

sections of the casting, are arranged in consecutive order away from the riser. In Fig. 23 the thick end of the wedge was up. Primary solidification occurred in the lower part of section C and

Fig. 18—Radiograph of Steel Casting Showing Pipe at the Base of the Riser, Caused by the Riser Freezing at the Base. The Dark Area in the Upper Left-Hand Corner is the Pipe at the Base of the Riser. The Light-Colored Figure "Five" is the Image of the Lead Marker Used in Identifying the Section of Casting from Which the Radiograph Was Taken.

the upper part of section D. The lower part of section D was kept hot by the presence of the gate. Solidification in the lower part of the casting was rapid. There was relatively large sec-

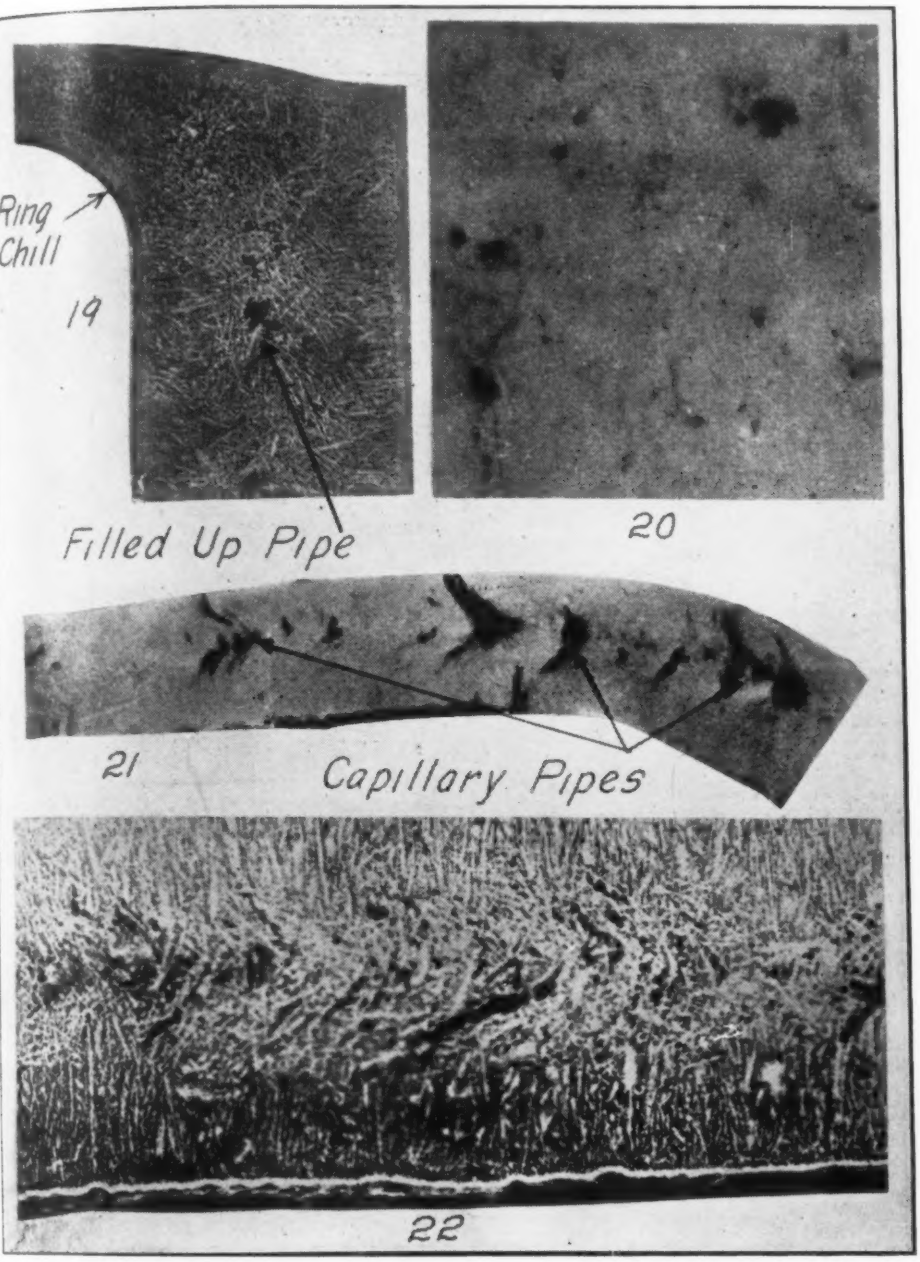


Fig. 19—Photograph of Deeply-Etched Section of the Steel Casting Shown in Fig. 16, Showing Manner in which Pipe Was Displaced from the Normal Position. The Pipe in this case was Filled with Fine-Textured Metal that had Flowed in from the Riser. Due to Presence of Chill, there is a Crescent-Shaped Section of the Fine-Textured Metal in the Fillet. This Chilled Section Serves to Bond the Bolt Flange and the Wall Section, and this Bonding Tends to Prevent Cracks. Fig. 20—Radiograph of Steel Casting Showing Capillary Piping. This Condition Exists in a Thin Sheet through the Center of the Section. It Constitutes a more or less Porous Core Caused by the Difficulty of Feeding the Center of Section during Last Stages of Solidification. Fig. 21—Radiograph of Cross Section of Steel Casting taken in Direction of Secondary Flow. The V-Shaped Marks are Small Pipes, Enlarged in this case, by the Presence of Gas. Compare with Fig. 18. Fig. 22—Photograph of Deeply-Etched Section of Steel Casting Showing Broken Structure in Porous Center where Metal-Flow Occurred during Final Stages of Solidification.

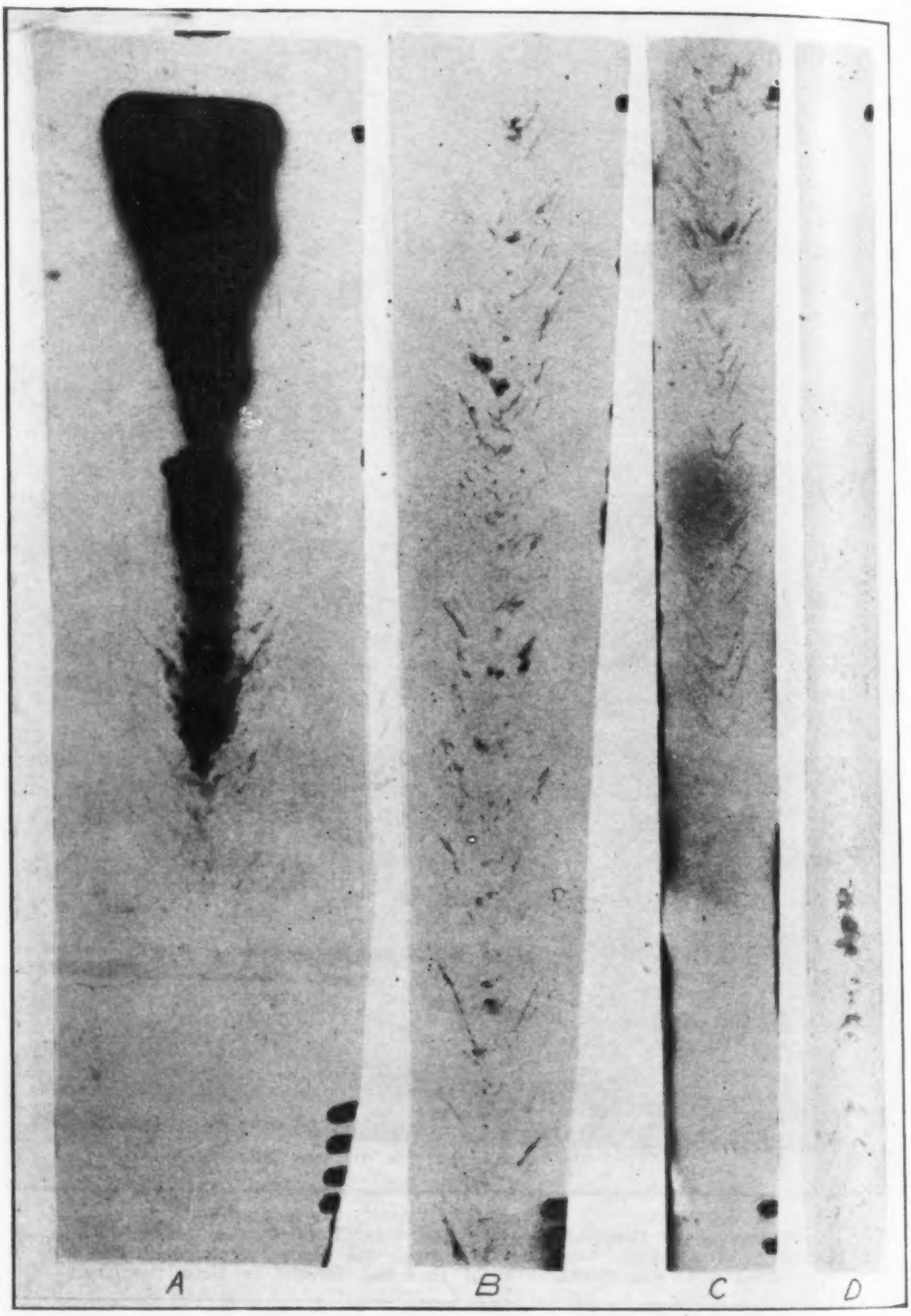


Fig. 23—Radiograph of Section through an Experimental Steel Casting Showing V-Shaped Pipes. These Pipes Indicate the Direction of Flow in Final Stages of Solidification. In this case, the Feeding was Down, inasmuch as the Region of Primary Solidification was at the Bottom. Sections A, B, C and D were taken in order from Top of Casting to Bottom.

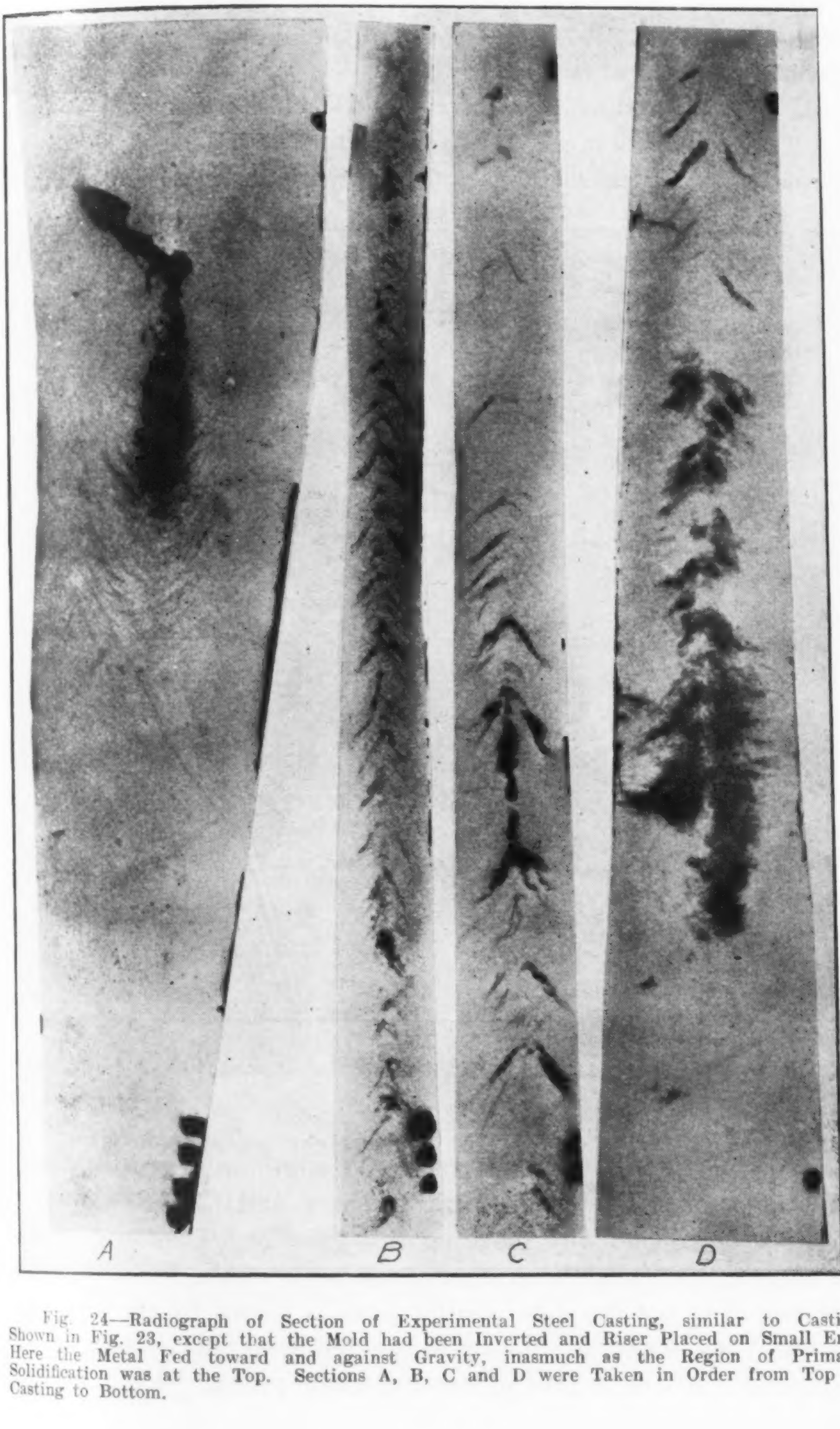


Fig. 24—Radiograph of Section of Experimental Steel Casting, similar to Casting Shown in Fig. 23, except that the Mold had been Inverted and Riser Placed on Small End. Here the Metal Fed toward and against Gravity, inasmuch as the Region of Primary Solidification was at the Top. Sections A, B, C and D were Taken in Order from Top of Casting to Bottom.

ondary flow and the V's indicate capillary piping almost up the base of the riser. In Fig. 24 the thin end of the wedge was up and primary solidification occurred just beneath the riser. The V's indicate that feeding was upward and against gravity in this case.

This observation is interesting in that it indicates that in the secondary flow the metal is pulled toward the region of primary

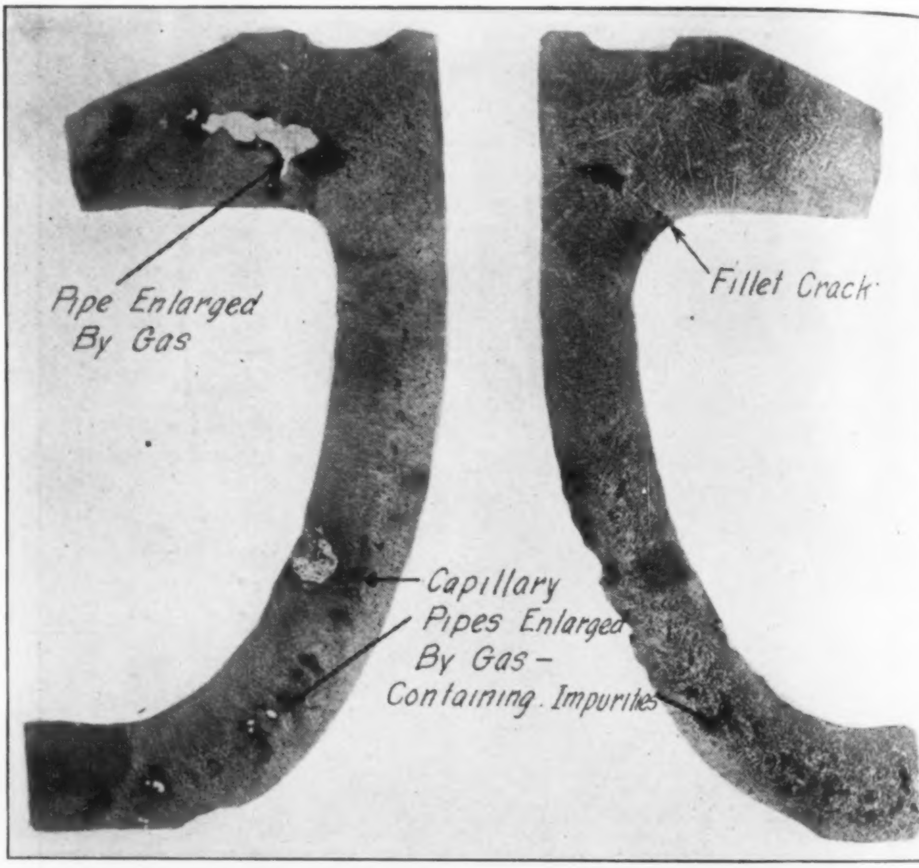


Fig. 25—Photograph of Deeply-Etched Cross Section of Steel Casting Showing Pipes and Cracks.

solidification by virtue of its tensile strength to a greater extent than it is pushed by hydrostatic pressure and that, as shown in Fig. 24, it will actually move against gravity. That gravity has an effect is shown in the greater prominence of the V's in Fig. 24, but that it is not the determining force is shown by the direction of the V's. Fig. 25 illustrates the tendency for impurities to accumulate in the region of the capillary piping. Fig. 26 illus-

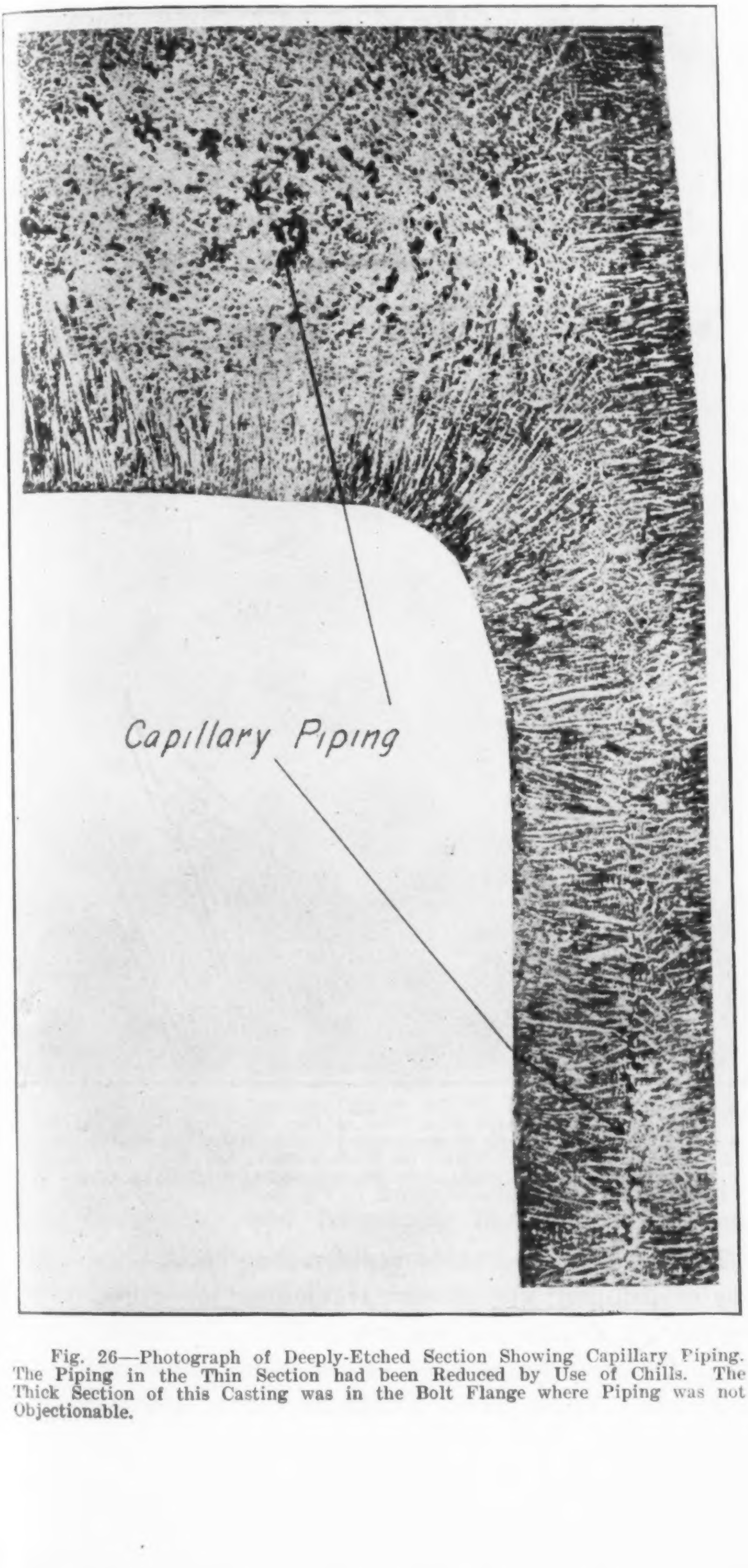


Fig. 26—Photograph of Deeply-Etched Section Showing Capillary Piping. The Piping in the Thin Section had been Reduced by Use of Chills. The Thick Section of this Casting was in the Bolt Flange where Piping was not Objectionable.

trates a case where this type of piping was overcome by a proper adjustment of risers and a judicious use of chills.

Cracks

Shrinkage during solidification is due to a relatively abrupt change in volume when the metal changes from liquid to solid. After solidification the metal continues to shrink, but more gradually.

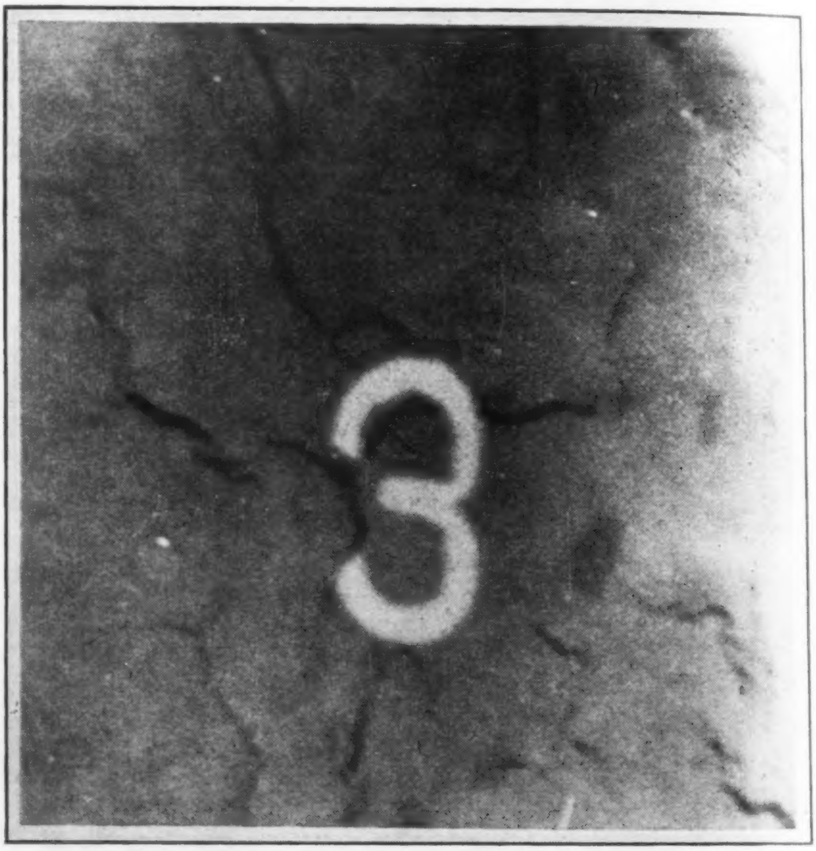


Fig. 27—Radiograph of Plan View of Fig. 28. This Radiograph Shows a Series of Cracks. None of these Cracks were Visible on Outside Surface of Casting. A Few were Visible on Inside Surface, but Many did not Show on either Surface. The Light Area in the Upper Right-Hand Corner is a Portion of the Weld-Section as Shown in Fig. 28.

Thin sections cool more rapidly than thick ones, and where sections of different thicknesses are joined the different rates of cooling set up stresses in the metal that may exceed its tensile strength. The result may be as shown in Fig. 27, which illustrates shrink cracks. These cracks constitute one of the worst evils the

foundryman has to combat. Cracks tend to occur especially where thin sections join thick ones at sharp angles, as for instance, where bolt flanges join thin wall sections. They are often prevented by filleting. With this method the thick section is graduated into the thin section. The shrinkage stresses are distributed in this way and may nowhere exceed the tensile strength of the metal. Bonding brackets and fillet chills are also employed to distribute stresses for the same purpose. Fillet cracks may be caused by other than unequal rates of cooling. Sometimes cores do not crush as the metal shrinks. Sometimes the molds set up stresses on flanges or other projecting members that may exceed the tensile strength of the metal. Cracks are usually welded. Unfortunately where cracks are caused by unequal rates of cooling there is often a system of branching cracks, only the main ones of which may be apparent on the surface. This main crack may be chipped out and welded, but this does not remedy the difficulty, because there still remains a system of sub-surface cracks or cracks that open to the inside instead of the outside surface and are not detected by the inspector. In Fig. 28 two of the cracks had been seen and partially welded, the others had never been detected. On account of this uncertainty it seems that the only safe remedy for cracks is the prevention of cracks. This may usually be done, although in some cases it will be found difficult or impossible to prevent cracks without modifying the design of the casting.

Welds

Foundries weld extensively. While it is better to avoid cracks than to weld them, the fact that welding is done must be recognized. Figs. 1 and 28 illustrate some welds that have been found in commercial castings. Sometimes, as in Fig. 28, the cracks are not completely chipped out and the crack is only partially welded. Sometimes, as in Fig. 1, the weld metal does not unite with the metal of the casting, and frequently the weld metal contains oxide and gas bubbles. If cracks are prevented the question of welding them does not come up. Other defects, such as sand pockets and blow holes, may be welded provided, of course, the welding is properly done. Here the defects are isolated and do not have hidden ramifications.

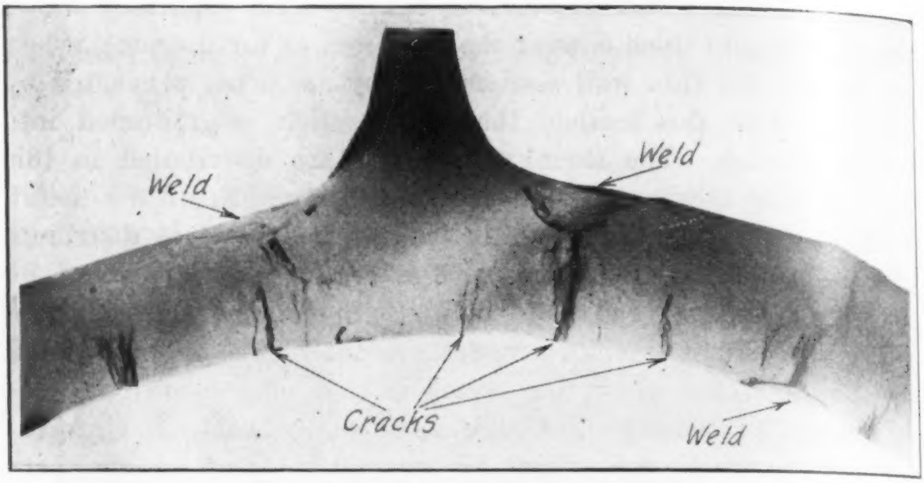


Fig. 28—Radiograph of Cross Section of Steel Casting Taken through Cracks. It will be Noted that Practically None of the Cracks Appear on the Outside Surface. A Number of them Open through to the Inside Surface, while Some of them do not Open to the Surface at all.

Summary

In this paper, casting defects as revealed by X-rays and collateral tests have been discussed. The defects as observed in castings may be summarized as follows:

1. Gas and sand pockets due to loose dirt in mold
2. Gas pockets due to imperfectly deoxidized metal
3. Sand inclusions due to cutting of mold or runners
4. Pipes caused by failure of risers to function as intended
5. Secondary pipes caused by flow of viscous metal through constricted channels in the casting during the final stages of solidification
6. Cracks
7. Bad welds.

Of these defects the first three are easily preventable, the fourth may be prevented, but the prevention may necessitate a modification of design. The fifth may not be overcome entirely, but may be reduced to a minimum. The sixth may be prevented, but here, too, a redesign of the casting may be necessary. The seventh will not come up when the other defects are cared for.

It would seem that steel castings can be made commercially sound. At least a great majority of present characteristic defects

may be avoided. However, to accomplish the desired end, laboratory study of casting technique is necessary. The great majority of defects are due to mistakes on the molding floor or casting floor. Very few defects can be traced to the metal in the ladle or furnace and these few are easily remedied. It has been the experience at Watertown Arsenal that characteristic defects tend to recur in exactly the same place unless steps are taken to correct the defect and that once a defect has been corrected by a change in casting practice, the defect is permanently eliminated. In the arsenal foundry, pilot castings are made and sent to the X-ray laboratory for study. The casting technique is modified on the basis of the laboratory reports until tests show sound castings. The job is then put into production with the developed technique. The success of this method may be indicated by an experience with one casting that had been particularly troublesome. Before this method of developing technique had been adopted, although the castings were subjected to the most rigid inspection, they frequently failed in service. Frequent post-mortems were held on the failures without great improvement in quality. After developing the technique with the assistance of X-ray studies a report came back from the consumer, "these are not only the finest steel castings we have seen from Watertown Arsenal, they are the finest steel castings we have ever seen." So far there is no record of failure of castings that have been made by means of technique developed with the assistance of X-ray examination.

Discussion of Dr. Lester's Paper

CHAIRMAN SAUVEUR: I am sure we all agree with Dr. Lester in regard to the importance of obtaining sound castings. There is no doubt that were it not for a justified fear that castings may contain inner defects, castings could be used more extensively in place of forgings. The work that Dr. Lester has done at the Watertown Arsenal should be very helpful to steel founders; it should tell them what to do and what not to do in order to produce better castings. The paper is now before you for discussion.

DR. W. P. DAVEY: As one who has done some of this sort of work, I should like to express my appreciation of what Dr. Lester has accomplished. It is not as easy of accomplishment as it would appear from what Dr. Lester has said. He has done a wonderful piece of work and has developed the technique to a point where it has never been developed before. The application of X-rays to foundry practice is quite remarkable. It may be an easy thing to prove, with paper and pencil, that most castings will not permit the

expense of an X-ray examination as a method of routine inspection, but it is easy to see that X-ray examination of foundry practice will more than justify itself financially. Any foundry that has a large number of castings of the same sort should have work done corresponding to what Dr. Lester has described, so as to make certain that the foundry practice for that type of casting is the best possible practice. There are no words of praise that are too high for the work that Dr. Lester has done.

Dr. Ancel St. John: I wish to emphasize what Dr. Davey has said. Dr. Lester's paper merits very great discussion and requires none. To reiterate a remark I made about a year ago when called upon to discuss similar work, the early work at the Arsenal, "it is time for men in the steel business to stop asking themselves, 'Can we afford to use X-rays in our business?' but ask the question, 'Can we afford not to use them?' "

J. Fletcher Harper: I would like to inquire as to the thickness of castings the author has been able to photograph with the X-rays; and roughly, the length of time, the current and voltage, etc., that is necessary for this work.

Dr. H. H. Lester: We can, with our present equipment, conveniently X-ray sections up to three inches in thickness. In inspection above three inches the cost of operation becomes so excessive that it does not pay. For instance, we can get a picture through three inches of steel with approximately thirty minutes exposure. If we go to four inches, as we have done, it takes 7 hours, and 40 minutes to obtain a picture. The operating potential necessary for this is about 200,000 to 250,000 volts.

J. Fletcher Harper: Roughly, what amperage would you use for a one or two-inch section?

Dr. H. H. Lester: The amperage varies depending on the potential across the tube. We run most of our work at about 7 milliamperes and 200 kilovolts. When operating at from 100 to 150 kilovolts, we run at about 10 milliamperes; on potentials from 220 to 250 kilovolts, we use between 4 and 5 milliamperes. The potential to be used depends upon the thickness of the metal, the kind of metal and the nature of the defects sought. To get the best definition, we use the lowest potential that is practicable and increase the exposure time. This procedure is used when we are searching for fine cracks. When we are interested only in larger defects, we use higher potentials because of the greatly increased economy of operation.

T. D. Lynch: I would like to add one additional thought to the paper of Dr. Lester, in emphasizing the importance of not putting too much stress on coupon tests as compared with the casting itself. I have just been carrying on a rather extensive investigation of a casting of great importance, about nine inches thick in the heaviest section, about thirty-six inches in diameter. Coupon tests were made on this casting, showing excellent results. Later, on account of the importance of the casting, we drilled test specimens from the most highly stressed portion of the casting, and these specimens instead of giving 25 per cent elongation and 45 per cent reduction, dropped to about 9 per cent elongation and about 10 per cent reduction—not because the casting was bad as was shown by some of Dr. Lester's radiographs, but

because of insufficient heat treatment. The time of heat treatment had been such as to refine the coupon properly, but it had not been long enough nor high enough to refine the interior of the casting. We made quite a number of tests and found that on the same casting, by doubling the time and raising the temperature, we were able to get the elongation and reduction of area inside of the casting to correspond to our coupon. We have therefore cast aside the coupon tests for important castings and have substituted tests from the casting itself.

R. F. Harrington: I would like to ask Dr. Lester if he has applied this to cast iron, and what the possibilities seem to be.

Dr. H. H. Lester: It can be applied to cast iron as readily as it can to steel. Cast iron does not have the number of cavities that you will find in the steel. It does have porous sections, where there is apparently an excessive precipitation of graphite and small gas bubbles, but as far as applying them, they can be applied to any metal.

THE INFLUENCE OF BARIUM CARBONATE UPON WOOD CHARCOAL USED FOR CEMENTATION

By B. F. Shepherd

Abstract

This paper illustrates the effect of barium carbonate in intensifying the carburizing properties of wood charcoal. It also shows that the quantity of barium carbonate which produces the best results is not the mixture which has been standard since 1861. A chrome-vanadium steel is also shown to absorb carbon much more readily than a simple carbon steel and to produce a hypereutectoid zone of such a depth and carbon concentration as to be extremely harmful.

WOOD charcoal was one of the earliest cements used to increase the carbon content of the surface of low carbon iron and steel objects. The action of various carbonates in accelerating the intensity of this reaction was discovered at a comparatively early date. The French scientist, Caron, in 1861, used a mixture of 60 parts of wood charcoal to 40 parts of barium carbonate, and this became known as the "inexhaustible cement" because of the action of the carbonate in regenerating or restoring the carburizing properties to used compound when exposed to the action of the atmosphere.

Procedure

The following experiments were made to determine the influence of various percentages of barium carbonate upon the carburizing properties of wood charcoal, the following compounds being used:

Compound	Wood Charcoal Per Cent by Weight	Barium Carbonate Per Cent by Weight
A	60	40
B	77½	22½
C	95	5
D	97½	2½
E	100	

A paper presented before the Society. The author, B. F. Shepherd, is assistant metallurgist with the Ingersoll-Rand Company, Phillipsburg, N. J.

Compound A, weighed 25 pounds per cubic foot, loose; compound E, 16¾ pounds loose, with an increase in weight of 36.9 per cent when packed. The barium carbonate, commercial grade, weighed 50½ pounds per cubic foot. The hardwood charcoal

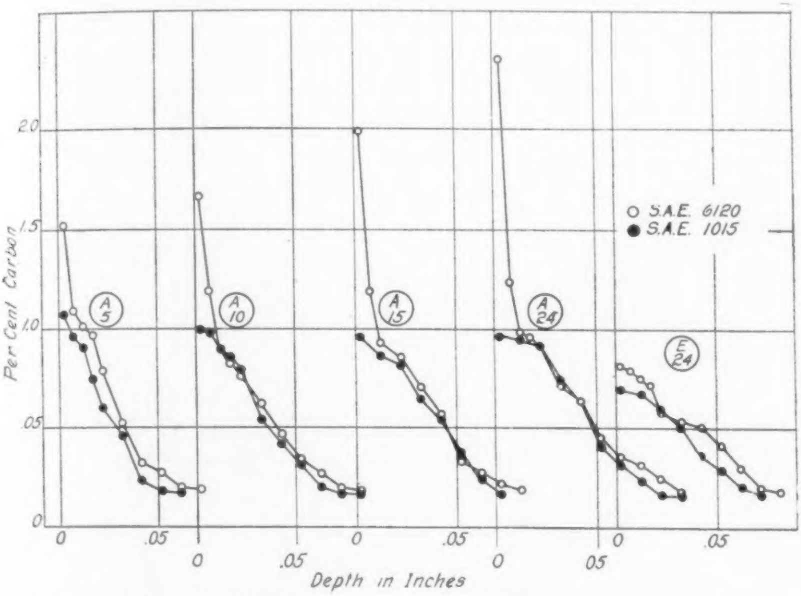


Fig. 1—Carbon Concentration Curves, Obtained with Compounds A and E, Using Varying Periods of Time for Carburization.

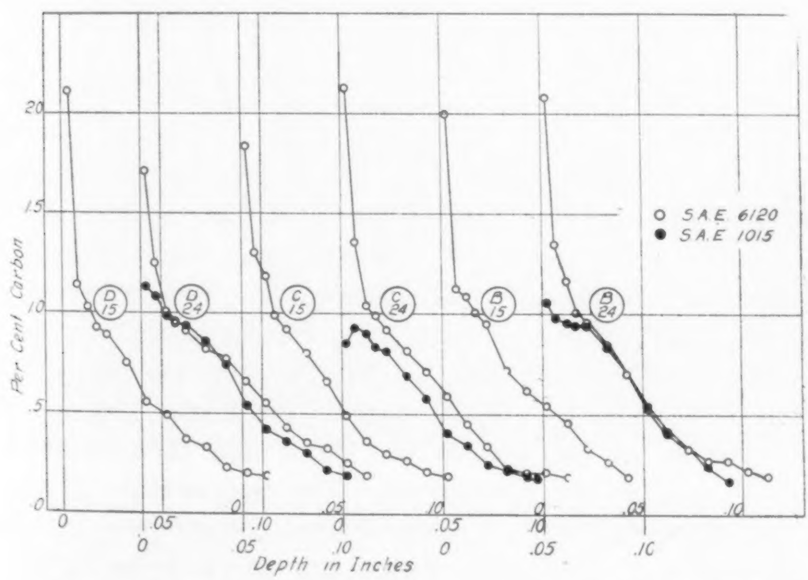


Fig. 2—Carbon Concentration Curves Obtained with Compounds B, C and D, Using Varying Periods of Time for Carburization.

used in these tests was obtained from a manufacturer who supplies this material for use in carburizing compounds.

Two steels of the following chemical composition were used:

	Carbon
S. A. E. Specification 6120..................	0.19 per cent
S. A. E. Specification 1015..................	0.17 per cent

The dimensions of the test pieces were 2 inches in diameter by 5 inches long, all taken from the same bar. All specimens were carefully ground to exact size. The shape of the pieces was

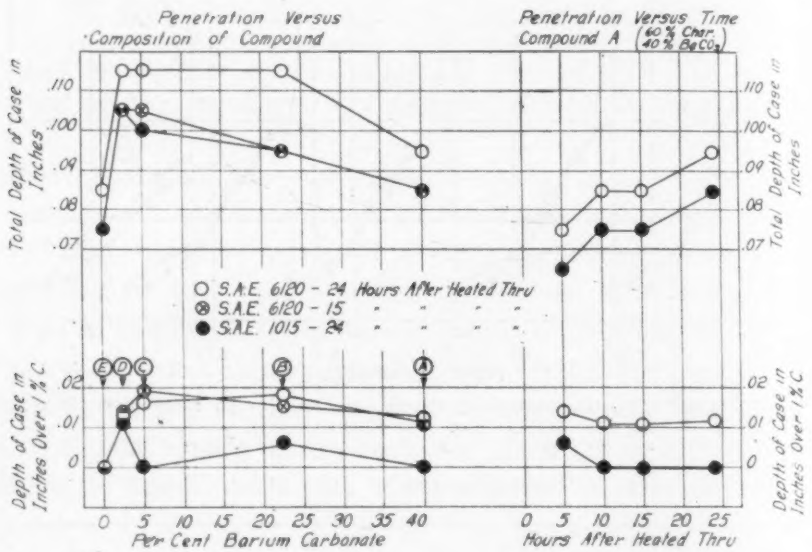
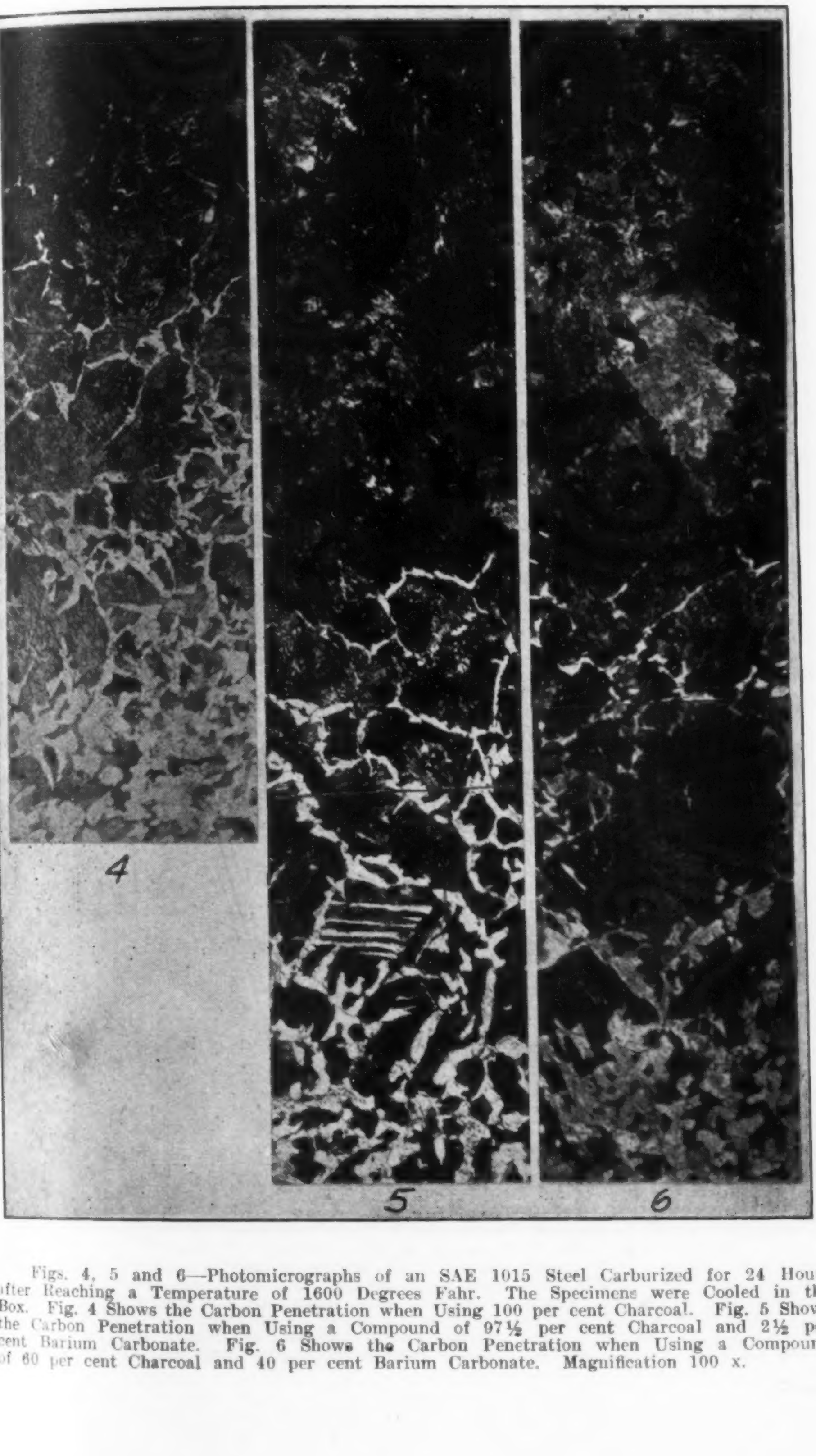
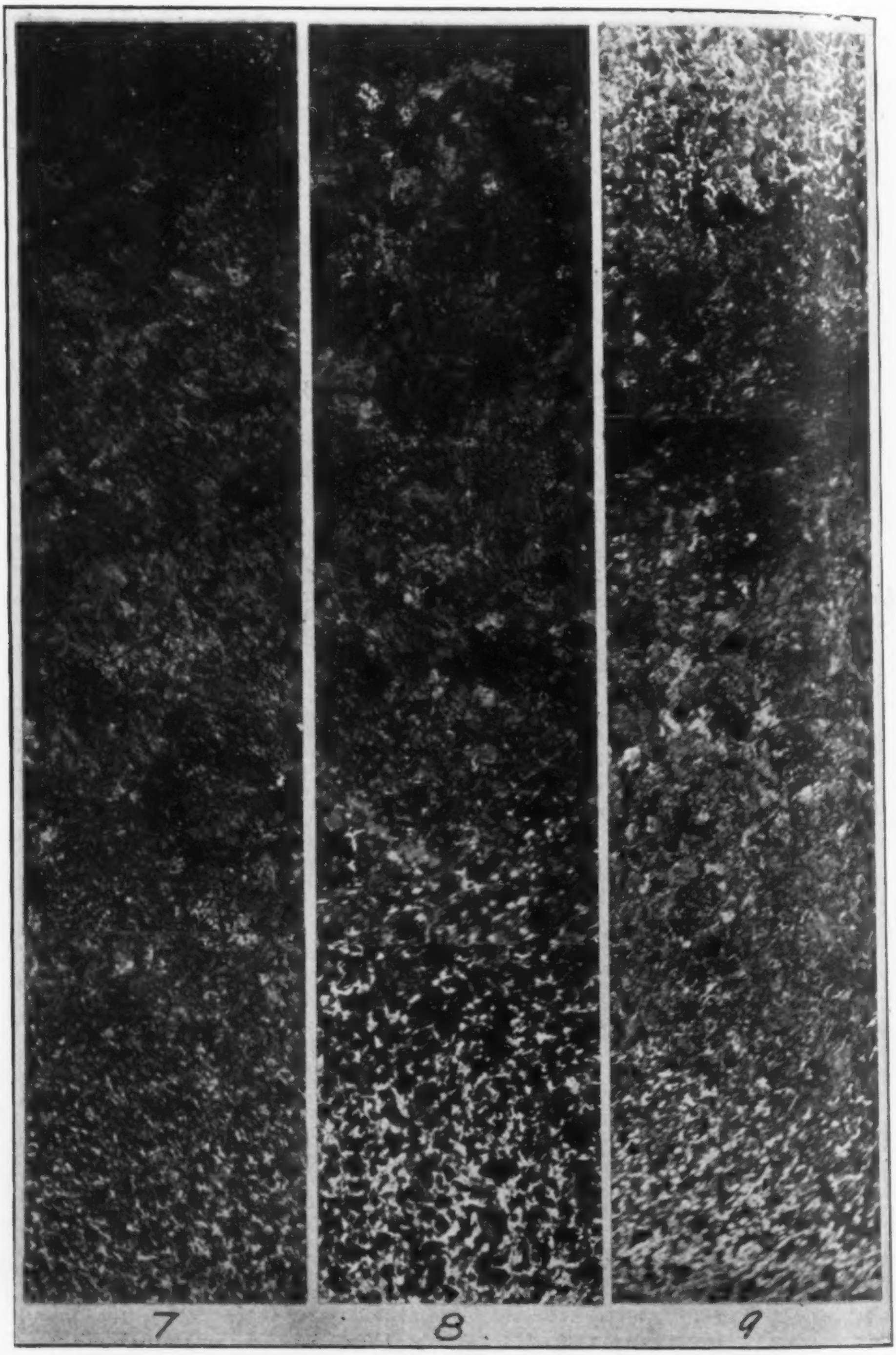


Fig. 3—Penetration Versus Compound Composition Curves Using SAE 6120 and SAE 1015 Steels. Penetration Versus Time Curves Using Compound A.

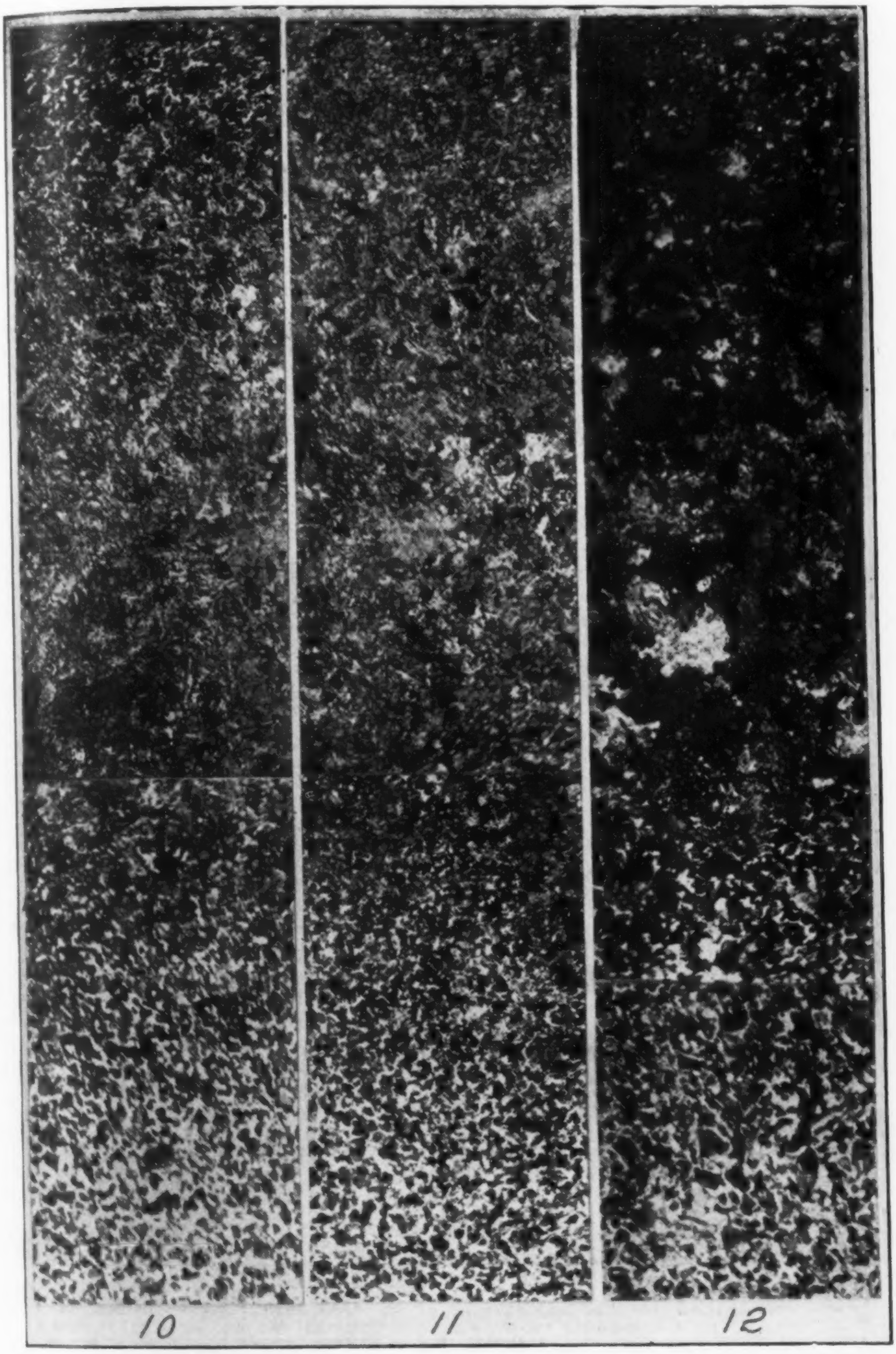
such as to reduce the liability of warping in the carburizing operation. The pieces were packed in an alloy carburizing box 12½ x 6½ x 7 inches deep (inside dimensions) with ¼ cubic foot (loose) of thoroughly mixed compound. The recessed lid of the box was carefully luted with clay. Eight hours were taken to heat the boxes through, this condition being estimated by eye. The boxes were held at 1,600 degrees Fahr. for the number of hours recorded in the various test runs, and then removed and allowed to cool in the atmosphere. The temperature of the furnace was measured with a standardized potentiometer recorder, held to within ± 15 degrees Fahr. and checked during the run with a portable potentiometer. The furnace was fired with fuel-



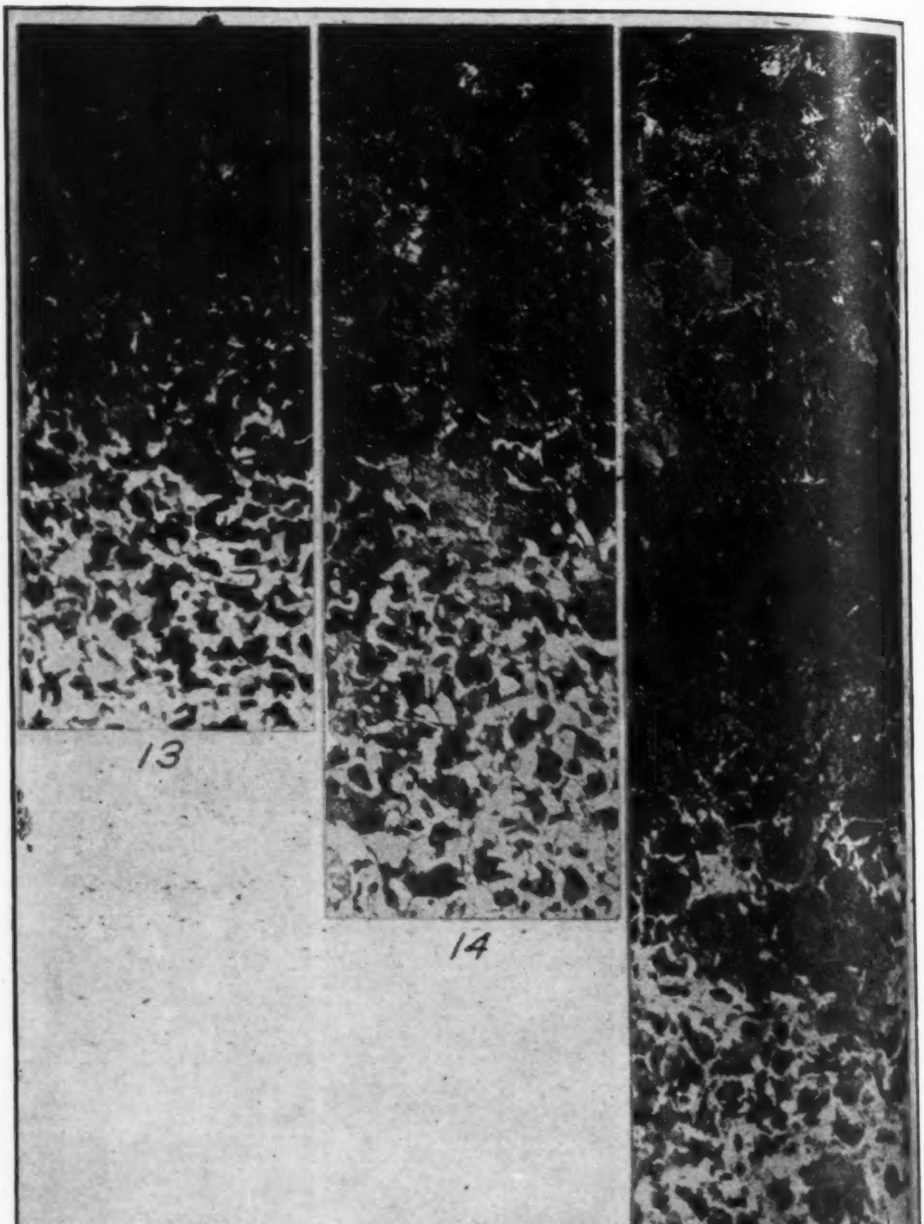
Figs. 4, 5 and 6—Photomicrographs of an SAE 1015 Steel Carburized for 24 Hours after Reaching a Temperature of 1600 Degrees Fahr. The Specimens were Cooled in the Box. Fig. 4 Shows the Carbon Penetration when Using 100 per cent Charcoal. Fig. 5 Shows the Carbon Penetration when Using a Compound of 97½ per cent Charcoal and 2½ per cent Barium Carbonate. Fig. 6 Shows the Carbon Penetration when Using a Compound of 60 per cent Charcoal and 40 per cent Barium Carbonate. Magnification 100 x.



Figs. 7, 8 and 9—Photomicrographs of an SAE 6120 Steel Carburized for 24 Hours after Reaching a Temperature of 1600 Degrees Fahr. The Specimens were Cooled in the Box. Fig. 7 Shows the Carbon Penetration when Using 100 per cent Charcoal. Fig. 8 Shows the Carbon Penetration when Using a Compound of 97½ per cent Charcoal and 2½ per cent Barium Carbonate. Fig. 9 Shows the Carbon Penetration when Using a Compound of 60 per cent Charcoal and 40 per cent Barium Carbonate. Magnification 100 x.



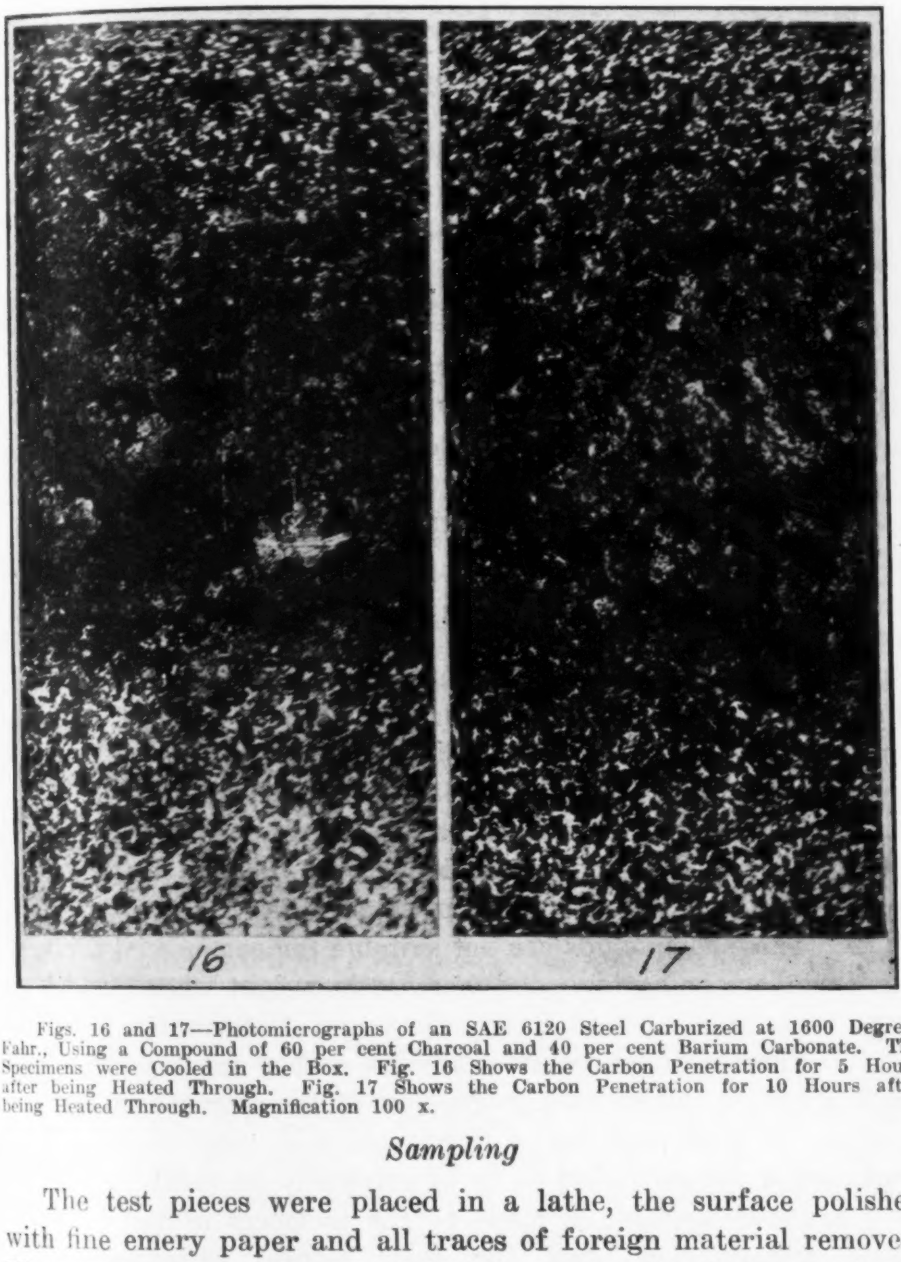
Figs. 10, 11 and 12—Photomicrographs of an SAE 6120 Steel Carburized for 15 Hours after Reaching a Temperature of 1600 Degrees Fahr. The Specimens were cooled in the Box. Fig. 10 Shows the Carbon Penetration when Using a Compound of 97½ per cent Charcoal and 2½ per cent Barium Carbonate. Fig. 11 Shows the Carbon Penetration when Using a Compound of 79½ per cent Charcoal and 22½ per cent Barium Carbonate. Fig. 12 Shows the Carbon Penetration when Using a Compound of 60 per cent Charcoal and 40 per cent Barium Carbonate. Magnification 100 x.



Figs. 13, 14 and 15—Photomicrographs of an SAE 1015 Steel Carburized at 1600 Degrees Fahr., Using a Compound of 60 per cent Charcoal and 40 per cent Barium Carbonate. The Specimens were Cooled in the Box. Fig. 13 Shows the Carbon Penetration for 5 Hours. Fig. 14 Shows the Carbon Penetration for 10 Hours. Fig. 15 Shows the Carbon Penetration for 15 Hours. Magnification 100 x.

oil and was of a construction which insured uniform heating of the boxes, which were carefully spaced on and supported off of the

furnace hearth by $1\frac{1}{2}$ inch legs. The loss in volume of the compounds is shown in Table I.



Figs. 16 and 17—Photomicrographs of an SAE 6120 Steel Carburized at 1600 Degrees Fahr., Using a Compound of 60 per cent Charcoal and 40 per cent Barium Carbonate. The Specimens were Cooled in the Box. Fig. 16 Shows the Carbon Penetration for 5 Hours after being Heated Through. Fig. 17 Shows the Carbon Penetration for 10 Hours after being Heated Through. Magnification 100 x.

Sampling

The test pieces were placed in a lathe, the surface polished with fine emery paper and all traces of foreign material removed. The corners were cut back $\frac{1}{4}$ inch to remove the increased depth of case obtained by the increased ratio of surface exposed to volume, and cuts 0.005 inches thick by 4 inches long were removed, mixed and analyzed for carbon by the standard gravimetric com-

Table I

Loss in Volume in Per Cent

Compound	Time at Temperature			
	5 hours	10 hours	15 hours	24 hours
A	23.3	33.3	33.3	33.3
B			33.3	33.3
C			37.5	37.9
D			35.4	37.5
E				37.5

bustion method. It was necessary to use extreme care in removing the outer layers on the chrome-vanadium steel, as the combination of high carbon with the alloys had made this steel self-hardening upon slow cooling.

Conclusion

The results of the individual analyses, many of them averages of several determinations, are shown in carbon-concentration curves, of Figs. 1 and 2. The summation of these results is shown in the curves of Fig. 3. Photomicrographs of some of the specimens carburized are shown in Figs. 4 to 17. As a result of these experiments the following conclusions have been drawn:

1. Additions of barium carbonate increase the depth of carbon penetration obtained with wood charcoal used as a carburizing agent, small percentages being most effective.

2. These compounds are not suitable for commercial mixtures, the shrinkage being high, the increase in weight when packed also high and the compound dusty, dirty and disagreeable to handle.

3. Chrome-vanadium steel absorbs carbon much more readily than a simple carbon steel, regardless of the strength of the compound. It also produces a hyper-eutectoid zone of such depth and carbon concentration as to be extremely harmful.

Acknowledgement is made to the members of the Ingersoll-Rand metallurgical staff for their helpful assistance in the preparation of this paper.

SOME NOTES ON CARBURIZED PISTON PINS

By R. S. Archer

Abstract

This paper is a short discussion of the manufacture and heat treatment of piston pins used in the Liberty aircraft engines which were produced in large quantities during the World War. Types of steels used, their heat treatment and methods of testing, are briefly described.

IN THE manufacture of the Liberty aircraft engine, the usual difficulties in the production of carburized parts were encountered. The most important problem and the most difficult of solution was that of the piston pin. In the early days of the program, piston pin failures were much too frequent and a number of engines were wrecked from such failures.

The piston pin was approximately 4½ inches long by 1¼ inches outside diameter. As originally designed the bore was tapered from both ends toward the center in order to have the greatest thickness of metal at the point where the greatest bending stress was developed. This was later changed to a straight bore.

Many aircraft engine piston pins were made from medium carbon alloy steel, oil hardened and tempered to a scleroscope hardness of about 55. This undoubtedly gives the strongest and safest pin to use from the standpoint of breakage. It is not safe, however, to allow the scleroscope hardness of such a pin to run over 55 to 60. As this hardness was not satisfactory to the designers of the Liberty engine a carburized pin was specified.

Causes of Failures

The piston pin failures were nearly always traced to too hard a core. This was caused by (1) using steel of too high carbon content, (2) improper carburizing practice, allowing the carbon to penetrate too deeply or to enter from the inside of the bore, or (3) the excessive core hardness when both these conditions were

---

A paper by R. S. Archer, Research Bureau, Aluminum Company of America, Cleveland.

fairly satisfactory might be caused by too high a hardening temperature.

Methods of Testing Pins

Methods of testing pins were gradually developed to a state which finally gave such satisfactory inspection that no further failures in engines were recorded. These tests consisted in a crushing test of a small percentage of pins and a 100 per cent scleroscope inspection on both the case and the core of the pins.

The crushing test was made by placing the pin, after hardening but before grinding, on supports having a width of ½ inch placed under the ends of the pin. A load was then applied at the center through a block having a face ½ inch wide. Under these conditions the load at the first failure or yield point was not to be less than 35,000 pounds. Probably more important than the actual load itself was the observation of the fractures produced in this test.

Inasmuch as the pins were cut to length after carburizing, the ends of the pin exposed surfaces which had not been carburized except from the outside surface of the pin. It was, therefore, possible to measure the scleroscope hardness of the core directly on the end of the pin. This hardness was held within the limits 35 to 55. The hardness on the case was specified at a minimum of 70.

Types of Steel Used

The first steel which was used for these pins was a low chrome nickel steel according to S. A. E. specification 3120. This was soon changed to S. A. E. specification 3320 which contains approximately 3 per cent nickel, 0.90 per cent chromium, and 0.20 per cent carbon. It was possible to produce excellent pins from this steel, but it was found that the hardening temperature had to be controlled within limits which were too narrow for production work under the conditions obtaining at that time. The type of steel which was finally adopted was of S. A. E. specification 2315. This contains 3.5 per cent nickel and 0.10 to 0.20 per cent carbon. As a matter of fact the steel actually used came closer to the S. A. E. specification 2320, having a carbon content varying from 0.15 to 0.25 per cent.

A great deal of work was done on the nickel steel piston pins to determine the best conditions of manufacture. The conditions which were finally adopted as the most satisfactory, were the result of much experience both in the laboratory and factory. In brief the procedure was as follows:

The pins were packed in the carburizing box with the bore drilled to only 5/8 inch diameter, as it had been found that plugging with clay was not sufficient protection against carburization on the inside. The carburizing temperature was held below a maximum of 1675 degrees Fahr., the preferred range being 1600 to 1625 degrees Fahr. After carburizing, the pins were cooled in the box and then cut to length and drilled out to the final diameter of approximately 7/8 inch. The time of carburizing was so controlled as to produce a depth of case which after grinding would be from 0.020 to 0.040 inch. The pins were then given a refining heat at 1550 degrees Fahr. and quenched in oil. They were hardened at 1340 to 1355 degrees Fahr. from lead. Most of the manufacturers used oil for this hardening.

Impact Tests

In order to determine the effect of hardening temperature on the toughness of the core, some impact tests on the carburizing stock were carried out in the laboratory. This stock was put through exactly the same heat treatment as the piston pins, but the impact test pieces were cut so far from the surface of the stock that the carbon did not penetrate to them. A series of pieces were hardened at temperatures throughout the entire possible range. This was carried out on steels of two compositions. the first containing 0.21 per cent carbon and the second 0.32 per cent carbon. The maximum amount of carbon permissible was fixed at 0.25 per cent, but it was desired to determine the effect of accidentally passing this limit. The impact tests carried out on the Izod machine showed that the resistance to impact of the 0.21 per cent carbon steel, decreases continually from about 50-foot pounds when quenched at 1330 degrees Fahr., to 35-foot pounds when quenched at 1410 degrees Fahr. This shows that a 0.20 per cent carbon steel of this specification has very good impact resistance when hardened at any temperature through the commercial range. The impact strength of the 0.32 per cent carbon steel

decreases rapidly with quenching temperature and reaches the very low figure of 10 to 15-foot pounds when quenched at 1340 to 1355 degrees Fahr. This is exactly the range of temperature preferred in hardening the carburized pin, and the danger of high carbon stock for stressed carburized parts is forcibly illustrated. When quenched at temperatures higher than 1355 degrees Fahr. the resistance to impact increased somewhat but not enough to make a good product.

Hardening Temperatures

In the course of experiments on piston pins, hardening temperatures were determined for the various materials used and may be given here as information of use in hardening articles of similar dimensions. For a straight carbon steel the best hardening temperature was found at 1400 degrees Fahr.; for a chrome-vanadium steel containing 0.70 per cent chromium and 0.08 per cent vanadium, it was found that only with difficulty could the case be hardened by oil quenching to a scleroscope value of 70. On quenching in water it was found that satisfactory hardness could be obtained at 1420 degrees Fahr., but not at 1410 degrees Fahr. The hardening temperature adopted for experimental chrome-vanadium pins was 1435 degrees Fahr. As mentioned before, the hardening temperature for the 3.5 per cent nickel pins was 1340 to 1355 degrees Fahr. The same temperature was also used for the pins of S. A. E. steel X-3320, when this steel was used.

TEMPERATURE DISTRIBUTION IN STEEL BODIES HEATED AT A CONSTANT HEAT POTENTIAL

By E. J. Janitzky

Abstract

This paper is a continuation of an article which appeared in the February, 1924, issue of Transactions, entitled, "Characteristics of Heating Curves—Their Applicability for Calculating the Time Required to Reach Constant Head Temperatures." The contentions set forth in the previous article are herein extended to temperature distribution in steel bodies heated at a constant heat potential.

IN THE article entitled "Characteristics of Heating Curves," the writer dealt with the question of the time required to heat a steel body under constant heat potential. The present article applies the same contentions to the temperature distribution at corresponding time intervals.

It is obvious that the formula

$$t^{o} = (T^{o} + 1) - \frac{T^{o}}{(t+1)^{(t+1)}},$$

in which T^o is the head temperature and t the amount of time constants or fractions thereof, represents the surface or outside temperature. By substituting in the exponent (t+1), 1=0, the formula will read

$$t^{o} = (T^{o} + 1) - \frac{T^{o}}{(t+1)^{t}}$$

and will represent temperatures at different time intervals in the center axis.

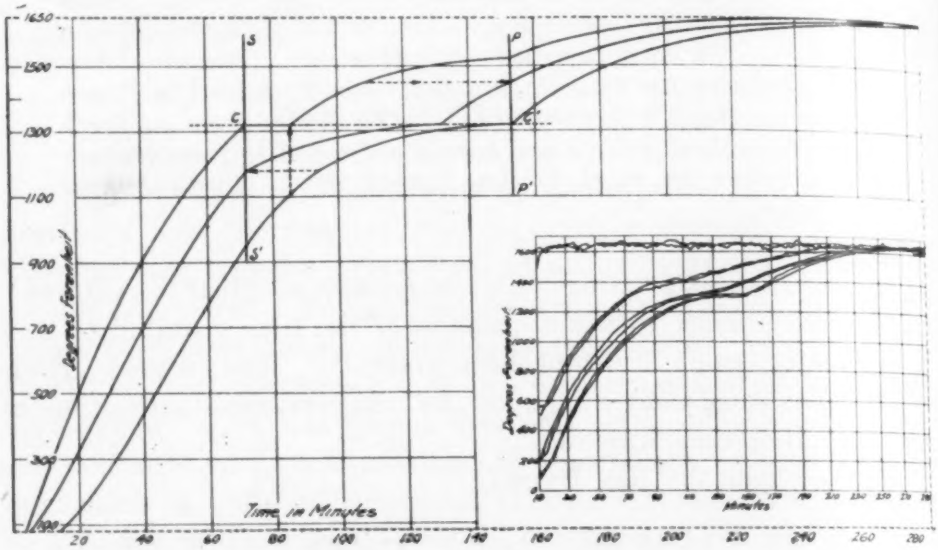
Adding to the t of the exponent, in the previous formula, decimal fractions representing the distance from the center toward the surface, one obtains results which approximate temperature values for time intervals at distances according to the decimal used. For one-quarter distance of the center, the exponent will read (t+ .25); for midway (t+.50); etc.

The outlined method, however, reaches its limit at the start

The author of this paper, E. J. Janitzky, is metallurgical engineer with the Illinois Steel Co., South Chicago, Illinois.

of the critical range. For temperature curves over the critical range the conditions are somewhat complex but can be overcome.

One must calculate and plot the time temperature curves by means of a time constant m′ which obliterates the critical point. The time constant m′ is a continuation of the curve of time constants under the critical point and is obtainable by dividing the



Plotted Time-Temperature Curve with a Graphic Insert of E. F. Law's Experiment with an 18-inch Cube Heated to 1650 Degrees Fahr. Showing the Temperature Distribution of Surface, Midway and Center, which Strikingly Resembles the Calculated Curves.

temperature for which it is sought in 6000. The values obtained satisfy the requirements for temperatures used in steel heating.

By shifting to the right the part of the so-obtained curve which lies above the critical range, corresponding to the time of sojourn in the critical range, one obtains two parts of the main curves which are not affected by the retarding action of the critical range.

The time of sojourn in the critical range equals,

$$m(t+1)-m'(t+1)$$

The surface and center curves after shifting, furnish two fixed points on the critical point line, CC′, which, upon plotting parallel lines vertical to it, include a space through which the curves deviate from the mathematical trend of the main curves, and represent the total time of sojourn in the critical range.

Let us denote the line intersecting the curve at the start of the critical range by SS′ and after passing by PP′. In order to obtain the trend of the curves within the critical range, it is necessary to find a curve which passes through the intersecting points of lines SS′ and PP′ with the center curve; in other words, a curve which represents a heating at constant heat potential, namely, the temperature of the critical point which in this case is 1320 degrees Fahr.

It is obvious that in order to obtain a curve of that trend a time constant m″ has to be found which will satisfy this condition. In the special case outlined below it was found that by dividing the time constant m by two, for the head temperature to which the body was heated, a close value for interpolation of m″ is obtained. All other curves within the critical range can be obtained by shifting the calculated center curve. The shifting of all curves below the critical point and within the center curve is to the left. In order to obtain the connecting link of the surface curve, the shifting is executed along the line PP′ in an upward direction. All other curves above the critical point and within the surface curve require a shifting to the right. The direction of shifting is indicated on the chart by arrows.

By applying the outlined method it is possible to obtain an insight into the temperature distribution at corresponding time intervals. The calculated and plotted time-temperature curve chart contains a graphic reproduction of E. F. Law's experiment with an 18-inch cube heated at 1650 degrees Fahr. and shows the temperature distribution of surface, midway, and center, which strikingly resembles the calculated curves.

Below is a sample calculation of three points at given time intervals of main curves and the calculation of the center curve within the critical range.

Before going to the calculations, the writer wishes to present three formulas which enable one to calculate the time in hours for heating bodies of various shapes at constant head temperatures when all surfaces are exposed to heating. In these formulas, D denotes diameter, size or thickness of the body.

Time in Hours	Spheres and Cubes............	.0127Dm(t+1)
	Rounds, Squares, Octagons, etc.	.0190Dm(t+1)
	Plates	.0380Dm(t+1)

Temperature Distribution After Seventy-Two Minutes

Time Constant for 1650° F.		m = 4.4 minutes
Time Constant Eliminating Critical Point— (6000÷1650)..........		m′= 3.64 minutes
Sojourn in Critical Range— (.0127x18x4.40x4.752)—(.0127x18x3.64x4.752) =	.80	hrs.= 48 minutes
Time Obliterating Critical Range— (.0127x18x3.64x4.752) ....T=	3.95	hrs.=237 minutes
Time Constants Elapsed Corresponding to One Minute—(3.75÷237)		= .0158
Time Constants Elapsed Corresponding to Seventy-Two Minutes—(.0158x72)...........		t =1.1376

Surface .... $t^\circ=(T^\circ+1)-\dfrac{T^\circ}{(t+1)^{(t+1)}}$ = 1325° F.

Midway .... $t^\circ=(T^\circ+1)-\dfrac{T^\circ}{(t+1)^{(t+.5)}}$ = 1175° F.

Center .... $t^\circ=(T^\circ+1)-\dfrac{T^\circ}{(t+1)^{t}}$ = 955° F.

Temperature of Center Curve Within Critical Range After One Hundred Minutes

Time Constant for the Part of Center Curve Which Sojourns in Critical Range, Found by Interpolation		m″=2.147 minutes
Time Required to Reach Head Temperature of 1320° F.— T=(.0127x18x2.147x4.66)	2.29	hrs.=137.4 minutes
Time Constant Elapsed Corresponding to One Minute—(3.66÷137.4)		=.0266 minutes
Equivalent for One Hundred Minutes on Diagram: 100—(153—137.4)		= 84.4 minutes
Time Constants Elapsed Corresponding to Eighty-Four Minutes—(84.4x.0266)		t =2.245 minutes

Temperature on Center Curve Within Critical Range After One Hundred Minutes—

$$t^\circ=(T^\circ+1)-\frac{T^\circ}{(t+1)^{t}} \text{ .... } =1225^\circ \text{ F.}$$

Conclusion

In conclusion, the writer wishes to state that notwithstanding the empirical character of the formulas, the results, as confirmed by available actual data, enable one to obtain an insight into the temperature distribution at given time intervals of steel bodies heated up at constant heat potential.

STRUCTURAL EVIDENCE OF AN IRON-CARBON EUTECTOID

By Anson Hayes and H. E. Flanders

Abstract

In this paper the results of experimental work, which indicates that carbon existing in solid solution when the lower critical range is traversed very slowly, is distributed in the form of small rounded specks throughout the ferrite. This is considered a structural evidence of a eutectoid action.

A mechanism for the formation of the ferrite shell about the primary carbon spots, in partially graphitized white iron, is given.

Introduction

IN AN earlier paper, by one of the authors,[1] attention was called to the fact, that until graphitization of white cast iron has progressed to a considerable degree in the critical range, the temper carbon spot is at some point in contact with the solid solution. This is shown in Fig. 1. So long as this contact exists, that is, so long as the temper carbon spot is not completely enveloped in the ferrite shell, growth of the carbon spot is possible at this point of contact.

In specimens of partially malleablized iron, whose combined carbon content has been reduced to 0.3 or 0. 4 per cent by graphitization, the shell of ferrite around the temper carbon spot acquires considerable thickness and only a very small per cent of the carbon spots show the above mentioned contact. It is evident that as graphitization nears completion, islands of solid solution completely separated from the large temper carbon spots result. This is well shown in Fig. 2.

The idea that the combined carbon in these islands of solid

[1]Hayes and Diederichs, Transactions American Society for Steel Treating, Volume 3, page 393, 1923.

A paper by Dr. Anson Hayes, professor of physical chemistry and metallography and H. E. Flanders, graduate student in physical chemistry, Iowa State College, Ames, Iowa.

solution is precipitated on primary carbon spots (spots formed above the critical range) caused Archer[2] and Schwartz[3] to conclude that carbon must be slightly soluble in ferrite and Honda to suggest that carbon monoxide and carbon dioxide may act as a carrier of the dissolved carbon through the ferrite to the temper carbon spot.

Purpose of Investigation

It is the purpose of the present paper to show that a very large portion of the carbon precipitated at the iron-carbon eutectoid is not precipitated on the carbon spots which existed above the temperature of the iron-carbon eutectoid. If none of the eutectoid carbon is precipitated upon the primary temper carbon spots, the assumptions of Archer and of Schwartz, as well as that of Honda, become unnecessary, though the mechanism suggested by the latter may be shown to be feasible, if cementite is assumed to be metastable at the temperature of the iron-carbon eutectoid. A complete thermodynamic treatment of this point has been worked out and will be included in a future paper. The reason that the mechanism suggested by Honda does not operate between the solid solution and the primary carbon spots to a much greater extent during precipitation of alpha iron and temper carbon is probably due only to the slowness of the action of these gases through the comparatively large distances over which carbon would be transported. It is entirely possible that they constitute the carrier over the much smaller distances involved between solid solutions and the very small eutectoid carbon spots.

Honda and Murikami[4] have presented data to show that carbon monoxide and carbon dioxide catalytically decompose massive cementite at temperatures slightly below those for the completion of solidification of iron-carbon alloys of high-carbon content. In their work they report decomposition of massive cementite "in situ," which is contrary to findings of Philips and Davenport.[5]

---

[2]R. S. Archer, *Transactions* Institute of Mining and Metallurgical Engineers, Vol. 67, page 456, 1922.

[3]H. A. Schwartz, *Transactions* Institute of Mining and Metallurgical Engineers, Vol. 1181S, 1922.

[4]*Journal* of Iron and Steel Institute, Vol. 102, page 287, No. II, 1920.

[5]*Transactions* American Institute of Mining and Metallurgical Engineers, 1117S, January, 1922.

The authors present Figs. 3 and 4, which seem to indicate that deposition of carbon may be initiated, both from the massive cementite and from the solid solution, at high temperatures. Here, larger carbon spots are, in most cases, in contact with the cementite areas, while there are also many smaller carbon spots in the solid solution regions.

Former Investigation Key to This Work

While working on a former paper, it was noticed that by extremely careful polishing of a sample of malleable iron with rouge, there appeared a large number of small carbon spots scattered throughout the ferrite. This suggested itself as a possible structural evidence of the iron-carbon eutectoid action taking place throughout the solid solution and not by a transfer of carbon to the primary carbon spots. By polishing more carefully on a chamois skin kept wet with water, the number of these small carbon spots became striking. It was then considered that if these carbon spots were a result of the iron-carbon eutectoid action they should disappear when a sample of malleable iron is heated above the range and reappear as the solid solution graphitizes on slow cooling.

Procedure of This Investigation

To test this idea, samples of commercial malleable iron were heated to a temperature of about 1625 degrees Fahr. for a day. This extended heating was to insure a saturated solution corresponding to the stable system, i. e., iron and carbon. The temperature was then lowered at the rate of 16 degrees Fahr. per hour to a temperature of 1425 degrees Fahr. when a sample was taken out and quenched. The photomicrograph, Fig. 6, shows a complete martensitic structure with a little troostite and scarcely any small carbon spots. At this temperature there had been no action of the iron-carbon eutectoid. Samples taken out before this one showed a similar structure. Another sample quenched at 1375 degrees Fahr. did not show any eutectoid action.

Photomicrograph, Fig. 7, is of a sample quenched just as the temperature 1330 degrees Fahr. was reached and shows the beginning of the eutectoid action in the grain boundaries and around

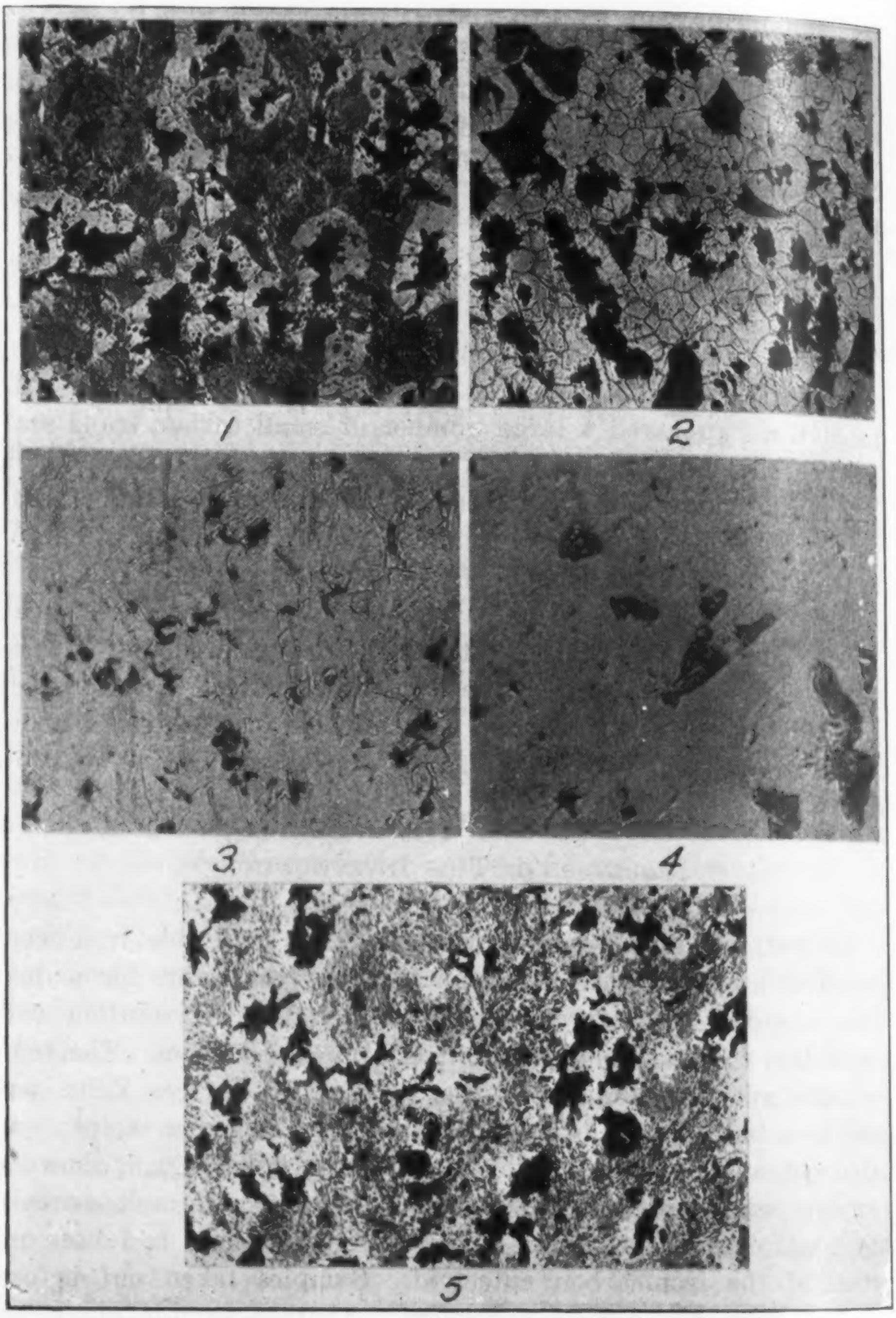


Fig. 1—Shows Temper Carbon Spot Incompletely Enveloped in a Ferrite Shell, Which Permits the Growth of the Carbon Spot at Point of Contact with the Solid Solution. Fig. 2—Shows Islands of Solid Solution Completely Separated from Large Temper Carbon Spots. Figs. 3 and 4—100 and 400 diameters, Indicate that the Deposition of Carbon May Be Initiated Both from Massive Cementite and from the Solid Solution, at High Temperatures. The Larger Carbon Spots Are Usually in Contact with Cementite Areas. Fig. 5—Partially Malleablized Iron Which Has Been Cooled Rapidly Through the Range, Showing Many Small Carbon Spots in the Solid Solution Areas. x100.

the primary carbon spots. The absence of small carbon spots in the solid solution areas and their presence in the grain boundaries and in the "bull's eye" ferrite is very noticeable. The martensitic areas of the solid solution are fringed with troostite, which must not be mistaken for carbon.

The photomicrograph in Fig. 9 is of a malleable sample quenched at 1330 degrees Fahr. but one hour later than the last, shows the nearly complete graphitization of the piece. In the small areas of the solid solution, the small carbon spots are again absent while they are distinctly numerous in the ferrite areas. In this sample a few small islands of pearlite were found scattered in the piece, Fig. 10. This indicates that the iron-carbon eutectoid is in operation before the precipitation of pearlite begins.

A sample quenched at 1285 degrees showed the complete graphitization of the piece. This gives a time of between 4 and 5 hours during which the iron carbon eutectoid was operating to complete the graphitization of the malleable samples.

Examination of samples of partially malleablized iron which has been cooled rather rapidly through the range only once shows many small carbon spots in the solid solution areas. See Fig. 5. These spots are probably not all eutectoid carbon. An examination of Figs. 3 and 4 in this connection indicate that at temperatures just below that of complete solidification there are many small carbon spots. Many of these are undoubtedly present until this solid solution is completely decomposed.

When the completely malleablized iron, however, is reheated through the range, say to 1625 degrees Fahr. and held there for 24 hours, all of the small carbon spots, eutectoid and pro-eutectoid, are dissolved. When this is again slowly cooled, for temperatures above the critical range, carbon in excess of that necessary for the iron-carbon eutectoid value has an opportunity to diffuse over to the primary temper carbon spots and thus, on this second and subsequent heatings followed by slow cooling, only the eutectoid carbon spots remain, i. e., the solid solution areas are free from them.

We may consider the formation of the ferrite shell and the eutectoid action to take place as follows:

The precipitation of the first temper carbon and ferrite at the iron-carbon eutectoid is accompanied by deposition of the carbon on the primary carbon spot and the accompanying ferrite in con-

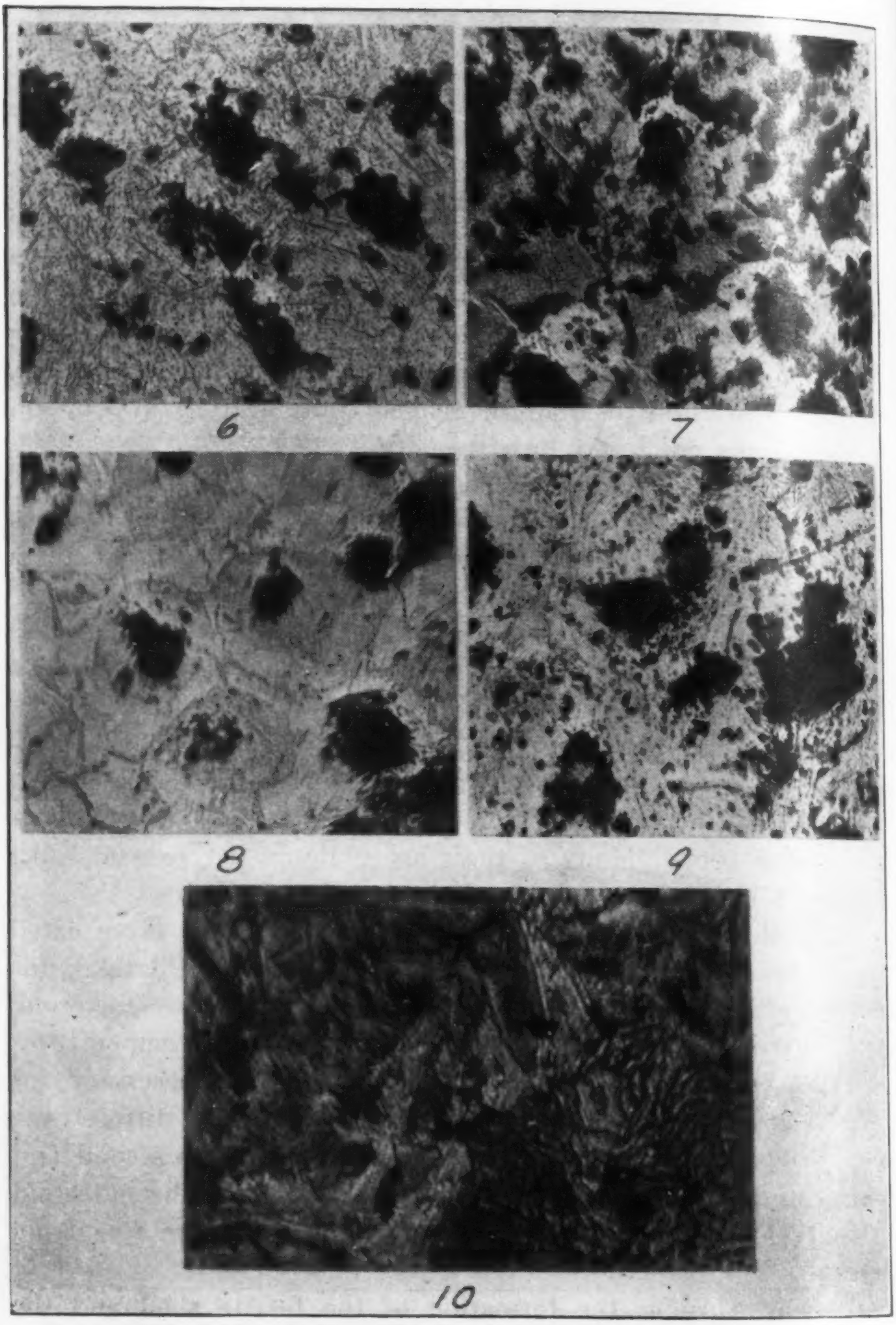


Fig. 6—Photomicrograph Showing a Complete Martensitic Structure with Some Troostite, with Scarcely Any Small Carbon Spots. Fig. 7—Photomicrograph of a Sample Quenched Just as the Temperature of 1330 Degrees Fahr. Was Reached, and Shows the Beginning of the Eutectoid Action in the Grain Boundaries and Around the Primary Carbon Spots. Fig. 9—Structure of Malleablized Sample Quenched at 1330 Degrees Fahr., One Hour Later Than Fig. 8, Showing Nearly Complete Graphitization of the Piece. Fig. 10—A Few Small Islands of Pearlite Are Shown Scattered Through the Area.

tact with it. Mahin[6,7] has shown that both metallic and non-metallic inclusions promote segregation of ferrite to a remarkable extent. In the present case, we have the allotropic form of carbon which is undergoing precipitation. We also have the lowest concentration of carbon in the solid solution in the vicinity of the temper carbon spot, since the solubility of carbon from carbon is less than it is from cementite.

The precipitation of the first ferrite about the primary carbon spot is due to two factors: First, the carbon spot promotes the precipitation of carbon, and second, it acts as an inclusion to promote the separation of ferrite. Eutectoid action after the ferrite envelope is completed takes place by the deposition of ferrite upon that already in the shell, while the carbon is precipitated throughout, forming the small carbon spots. These carbon spots may therefore be considered as evidence of a eutectoid structure.

Conclusion

In conclusion the authors would say therefore that:

First, the greater portion of the carbon precipitated at the iron carbon eutectoid is not ordinarily precipitated on the primary carbon spot and is present in a form which indicates a eutectoid structure.

If the gases CO_2 and CO act as carriers of carbon, they do so through the much smaller distances between solid solutions and the eutectoid carbon spots.

[6] *Journal* Industrial and Engineering Chemistry, Vol. 11, page 739.

[7] *Journal* Industrial and Engineering Chemistry, Vol. 12, page 1090.

Comment and Discussion

Papers and Articles Presented Before the Society and Published in Transactions Are Open to Comment and Criticism in This Column—Members Submitting Discussions Are Requested to give Their Names and Addresses

DISCUSSION OF V. N. KRIVOBOK AND O. E. ROMIG'S PAPER ENTITLED, "SURFACE STRUCTURE VERSUS INNER STUCTURE OF METALS"

By A. I. Krynitsky*

IN discussion of a very interesting paper entitled "Surface Structure Versus Inner Structure of Metals," by V. N. Krivobok and O. E. Romig, published in July issue of Transactions, the writer wishes to call attention to some observations made some time ago (June, 1920) in conjunction with the corrosion tests carried out in the Bureau of Standards on cold-worked tin.[1]

Specimens of high-grade tin intended for pyrometric standards were used in brief study of the properties of tin after deep corrosion. The cross section was reduced by cold-working from 2 by 4 centimeters to a strip approximately 0.15 centimeters thick, and the metal was then annealed for a period of 2½ hours at 150 degrees Cent. (302 degrees Fahr.) Acidified solutions of stannous chloride were the corroding liquids used.

The attack was distinctly more severe along the grain boundaries than in the interior of the grain. Some of the specimens exhibited a very peculiar and striking pattern upon corrosion, which was independent of and superimposed upon the granular or crystal structural pattern. That it is not entirely a surface roughening caused by adherence of corrosion products or by convection or diffusion currents within the corroding liquid appears evident from the fact that very slight corrosion (1 hour) was sufficient to reveal it and also that it was still very prominent after 4 days' attack. The fact that the metal was annealed indicates that the etch-pattern cannot be attributed to the uneven removal of relatively hard skin of the surface of metal.

This pattern was shown in the paper mentioned above and may be seen in the photographs—Figs. 1 and 2 of the present discussion.

The elliptical cells are running in the direction of casting, rolling and suspension in the corroding medium (in this case all these directions coincide) and they appear to be independent of the crystal boundaries and directions of Newman lines and of slip bands.

*The author of this discussion, A. I. Krynitsky, is Associate Physicist of the Bureau of Standards, Washington, D. C.

[1] "Corrosion Patterns on Cold Worked Tin and Zinc." By Henry S. Rawdon, Alexander I. Krynitsky and Julius F. T. Berliner. *Chemical and Metallurgical Engineering*, 1922, pages 212-213.

1

2

Fig. 1—Pure Tin Corroded for One Hour in a Normal Stannous Chloride in Alcohol and 0.64 Normal Hydrochloric Acid. 5 x. Fig. 2—Plate of Pure Tin Corroded for Four Days in a Normal Stannous Chloride in Alcohol and 0.64 Normal Hydrochloric Acid. 5 x.

On the passing from one crystal to the adjacent one they change their color on account of orientation of the new crystal, but they do not change their shape and direction.

The successive observations on this pattern under a binocular microscope were made at magnification as high as 76 diameter. After 4 days' corrosion these cells presented one of the appearances shown in Fig. 3.

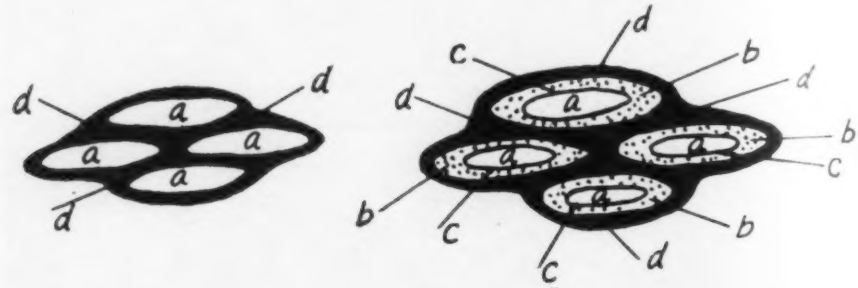


Fig. 3—Sketch of Structures Observed through a Binocular Microscope. 76 x. a—Solid Elevated Area; b—Spongy-like Area; c—Thin Groove; and d—Fairly Deep and Wide Groove. Although the Photograph cannot Show this Pattern as well as it may be Observed under a Binocular Microscope, this is Faintly Represented in Fig. 2.

Although the photograph cannot show this pattern as well as it may be observed under a binocular microscope this is faintly represented in Fig. 2.

These cells were found to be very persistent and in some cases they were noticed after 87 days of corrosion. In his attempt to explain the evident presence of these two structures independent and superimposed upon one another, the writer at that time referred to the hypothesis of Professor Quincke, observations of G. Gartaud[2] and the paper of Dr. C. H. Desch.[3]

According to Quincke, the metals and other substances, immediately before solidification from the liquid state separate into two immiscible liquids, one of which is formed in much smaller quantity than the other. These liquids have an interfacial surface tension and a foam is formed, the liquid present in smaller proportion arranging itself in cell walls, and the second constituting the cell contents. Crystallization then takes place within the foam cells, and the cell walls are represented in the solid mass by the boundaries of the crystal grains. The subsequent growth of the crystals forming the cell contents might distort the crystal cells, but could scarcely produce a complete change of type.

Dr. Desch believes that evidence has been obtained that surface tension has an important share in determining the form of the crystal grains in a solidifying metal, and that such grains have a tendency to assume the shape of foam cells, surface tension competing with the directive force of crystalline cohesion in determining the grain boundaries.

In discussing Desch's paper, Dr. Bengough demonstrated a curious structure of electro-copper which was melted in an atmosphere of hydrogen

---

[2]"Les rechershes de G. Gartaud sur le passage de l'état liquide a l'état solide" par F. Osmond. *Revue de Métallurgie,* 1907, pages 828-831.

[3]"The Solidification of Metals from the Liquid State," by Cecil H. Desch. The *Journal* of the Institute of Metals, No. 2, 1919.

Fig. 3—Sketch of Structures Observed through Binocular Microscope. 76 x. a—Solid

and allowed to cool slowly in the crucible. The metal was almost pure, the oxide being 0.008 per cent and silver 0.01 per cent.

A careful examination revealed that there are two entirely different structures quite separate and superimposed one on the other. He suggested that in this case there had been a separation into two immiscible liquids just before solidification, and this arrangement was partially but not entirely broken down by the crystallization, complete destruction being prevented by under-cooling and viscosity effects. The suggestion was that there was some pre-crystal cellular structure in this slowly cooled copper. The same kind of structure was found by Dr. Hudson in an alloy of tin with 7 per cent of antimony (discussion on Dr. Desch's paper).

The double structures were excellently demonstrated in the micrographs of G. Gartaud. The metals on which experiments of Gartaud were carried on were lead, tin, zinc, cadmium and bismuth. The metals were poured upon the inclined plates of glass in such a manner as to obtain very thin sheets of metals which were solidified almost instantly, and those faces of the sheets which were exposed to the air were examined microscopically.

In all cases except in the case of bismuth, cellular structure has been revealed. The cells observed were of various shapes: hexagonal, pentagonal, even triangular. In some cases they appeared to be elongated in certain directions. Very often also the crystals mixed with the cells were noticed. This was observed usually on those spots of sheets where the sheets were thicker, in other words on areas where the sheets were not cooled so rapidly.

According to Osmond these cells resemble "cellules tourbillons" which were observed in thin layers of the liquids by Bénard (1900). The Gartaud micrograph (magnification 50x) of lead etched with picric acid dissolved in acetone resembles very much the cells of the pattern (Figs. 1 and 2) of corroded tin cited above. Referring now to this pattern of corroded tin the writer points out that in this particular case the metal was cold-worked, and to accept the explanations as stated above would mean that this cellular structure was so persistent that it survived even such treatment to which the cast metal had been subjected. This is, however, rather questionable. Therefore the writer would prefer to confine himself to the statement that this phenomenon may, under certain conditions, be observed on the surface of deeply etched cold-worked and annealed tin.

The Question Box

A Column Devoted to the Asking, Answering and Discussing of Practical Questions in Heat Treatment — Members Submitting Answers and Discussions Are Requested To Refer to Serial Numbers of Questions

NEW QUESTIONS

QUESTION NO. 138. *Is the electrolytic pickling process being used to show up defects in steel bars? If so, how does it compare with the regular pickling processes?*

QUESTION NO. 139. *What is fibre, as related to forgings?*

QUESTION NO. 140. *Can fibre be removed by heat treatment? How and to what extent?*

QUESTION NO. 141. *Does fibre exist in castings which have been subjected to mechanical working?*

OLD QUESTIONS

QUESTION NO. 120. *How does the carbon content affect the secondary hardness of high speed steels?*

QUESTION NO. 130. *Is there any advantage in using notched-bar impact tests in the inspection of annealed tool steel bar stock? What does such a test show?*

QUESTION NO. 131. *Given an alloy of the brass or bronze type, in which there are no critical transformation points, suppose that through carelessness the metal has been overheated, producing an undesirably coarse crystalline structure, is it possible to refine the grain without remelting or mechanical work?*

QUESTION NO. 133. *In annealing a carbon tool steel of* 1.30 *to* 1.40 *per cent carbon, are there any ill effects to the steel in allowing it to soak for an hour or more at* 30 *to* 40 *degrees Fahr. above the critical point?*

QUESTION NO. 134. *What are the usual feeds and speeds used in machining both carbon and alloy automotive steels, when using high speed steel cutting tools?*

Continued on Page 639

Abstracts of Technical Articles

Brief Reviews of Publications of Interest to Metallurgists and Steel Treaters

THE FORGING OF AUTOMOBILE CRANKSHAFTS. By J. H. Nelson, research engineer, Wyman-Gordon Co., Worcester, Mass., in *Forging-Stamping-Heat Treating,* September, 1924, page 312.

The author of this article states that automobile manufacturers are demanding crankshaft forgings that require the least amount of machining and which will give nearly perfect dynamic balance, and gives a number of methods by which the desired results may be obtained.

HEAT TREATMENT OF STEEL SPRINGS. By J. K. Wood, consulting engineer, New York City, in *American Machinist,* September 18, 1924, page 443.

This article gives the general requirements for a spring. Spring steels and their compositions are discussed. The coiling, forming and heat treating of helical and leaf springs are also covered.

STRUCTURAL SEGREGATION IN GRAY IRON. By J. A. Bolton, metallurgist, Niles Tool Works, Hamilton, Ohio, in *Iron Age,* September 18, 1924.

The author states that cast iron is not homogeneous in structure, as it has numerous structural segregations, mostly dendritic. These segregations influence the physical properties of the metal. In this article, crystallization is reviewed; limitations of methods of analysis, microscopy and fracture are indicated and primary crystallization of cast iron is explained. The distribution of graphite is dependent largely on the type of primary crystallization of the metal. Brief mention is made of arrangement of pearlite, ferrite and steadite. Research in the author's laboratory indicates that graphite flakes are the most important indicator of cast iron's physical properties. The relations among structural segregation, composition and physical properties are carefully detailed from results of tests on commercial irons.

PRACTICAL METALLOGRAPHY. By S. P. Rockwell, consulting metallurgist, Hartford, Conn., in *American Machinist,* September 25, 1924, page 487.

The author gives the applications of the art of metallography to the solution of problems in the average plant; practical methods of procedure are also covered.

THE NEW ALUMINUM-SILICON ALLOYS. By J. D. Edwards and R. S. Archer, Aluminum Company of America, Cleveland, in *Chemical and Metallurgical Engineereing,* September 29, 1924, page 504.

This article describes an important process of modification, and the re-

markable improvement in properties it brings about. The modification of silicon-aluminum alloys consists of treating the molten metal with metallic sodium or a flux containing sodium fluoride, and results in an alloy of greatly increased strength and resistance to shock. These alloys are at present widely employed in the automotive field. Their application to other industries is rapidly increasing.

STEELS FOR FORGING MACHINE DIES. By E. R. Frost, manager, National Machinery Co., in *Forging-Stamping-Heat Treating,* October, 1924, page 368.

The above article was read at the meeting of the American Drop Forging Institute in 1923, and states that many variable factors enter into the choice of the best die steel. No definite formula or rule can be given which will cover the many conditions encountered.

ELECTRIC FURNACES FOR MEDIUM TEMPERATURES. By C. F. Cone, engineer, George J. Hagan Co., Pittsburgh, in *Forging-Stamping-Heat Treating,* October, 1924, page 375.

The above was presented at the 19th annual convention of the A. I. and S. E. E., Pittsburgh, September, 1924. The author states that the electric furnace of the regenerative car type has eliminated many troubles in the preliminary annealing of wire used in the manufacture of horse-shoe nails.

FOUNDRY TREATMENT AND PHYSICAL PROPERTIES OF SILICON-ALUMINUM SAND CASTINGS. By D. Basch and M. F. Sayre, Schenectady, N. Y.

This paper was presented at the annual meeting of the American Foundrymen's Association, Milwaukee, October 11th to 16th. The authors discuss the developments made during the last four years with silicon alloys of aluminum which have high physical properties and good foundry properties.

X-RAYS IN THE FOUNDRY. By Dr. Ancel St. John, New York City.

The above paper was given at the annual meeting of the American Foundrymen's Association, Milwaukee, October 11th to 16th, and gives a brief description of what X-rays are, how they are used for examining castings, and what they disclose, together with a consideration of the circumstances under which their use is justified.

MANUFACTURE OF CAST-IRON PIPE IN THE SOUTH. By Dr. Richard Moldenke, Watchung, N. J.

This article was read at the Birmingham Meeting, October, 1924, of the American Institute of Mining and Metallurgical Engineers, and describes the two new developments in the manufacture of cast-iron pipe. The advantages and disadvantages of both processes are presented in some detail. Statistics on the production of pipe in the United States at the present time are given, as well as in the plants situated in the South.

Reviews of Recent Patents

By
NELSON LITTELL, Patent Attorney
110 E. 42nd St., New York City
Member of A. S. S. T.

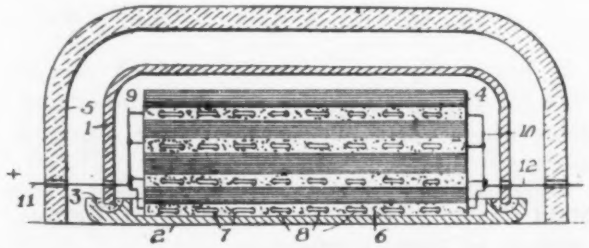
1,497,889, **Method of Making High Speed Steel, William Bertin Brookfield, of Syracuse, New York.**

This invention is for an improvement in the method of making high speed steels.

The inventor states that high speed steels when made in an electric furnace possess various quantities of non-metallic substances or inclusions which are detrimental to the tool and cause chipping or breakage thereof, whereas the steels made by the crucible method vary greatly in quality, making it practically impossible to obtain uniformity because of the large number of small batches which are melted in the furnace. He, therefore, proposes to secure uniformity in quality by first reducing the entire melt in an electric furnace under proper temperature to assure a product of maximum homogeneity and then transferring the molten metal from the electric furnace to a series of heated crucibles in a suitable crucible furnace where it is maintained above the melting temperature for a period of twenty to thirty minutes to allow the non-metallic inclusions or metalloids to collect at the surface where they are skimmed off before the metal is cast. By this method the economy and uniformity of electric furnace steel is obtained together with the high quality of the ''crucible'' steel.

1,503,639, **Method for Annealing Sheet Metal, Otto H. Cunningham, of Leechburg, Pennsylvania.**

Under the present practice of annealing sheet metal in packs of plates or sheets, it takes several hours for the heat to penetrate to the center of



the pack so to secure uniform heat throughout, a large amount of fuel is, therefore, unnecessarily wasted and the sheets of the outer edge of the packs are often ruined through overheating.

According to the present invention, the sheets 4 are piled or stacked with resistance elements 7 at suitable intervals between the layers of plates.

The annealing box 1 is placed over the stack of sheets on the base plate 2 with the edges sealed by the sand seal 3 and the pack is placed in the heating furnace 5. While heat is being applied to the exterior of the pack in the furnace 5, the interior of the stack of plates is also heated by passing a suitable electric current from the leads 11 and 12 through the resistance elements to heat the inside of the stack and quickly bring the entire stack to the proper annealing temperature, whereupon the heat may be cut off and the pack cooled according to the usual practice. By imparting heat to the interior of the stack as well as the outside the heating time is materially reduced and overheating of the edges of the pack is eliminated.

1,503,772, Alloy for High-Temperature Use, William H. Smith, of East Cleveland, Ohio, assignor to Electro Metallurgical Company, a Corporation of West Virginia.

This patent describes a high temperature resisting alloy, particularly for use in forming muffles, annealing boxes, etc., for heat treating, which is adapted to stand the repeated heating and cooling up to 1,000 to 1,200 degrees Cent. (1,832 to 2,192 degrees Fahr.) without becoming oxidized, cracked and disintegrated. The alloy preferably contains 8 to 15 per cent chromium, not less than 2.5 per cent of silicon, a fraction of one per cent of zirconium and the balance principally iron.

1,504,338, Alloy Comprising Iron, Nickel, Chromium, Tungsten, or Molybdenum. Pierre Girin, of Paris, France, assignor to Societe Anonyme De Commentry Fourchambault and Decazeville, of Paris, France.

This patent concerns an alloy which may be easily obtained in large quantities which is capable of being molded, forged, rolled and otherwise worked and which possesses at a temperature of 800 degrees Cent. (1,472 degrees Fahr.) a resistance almost equal to that of cold iron. The preferred composition of the alloy is as follows:

Nickel	60 to 70 per cent
Chromium	10 to 15 per cent
Tungsten	2 to 5 per cent
Manganese	1 to 2 per cent
Carbon	0.3 to 0.6 per cent

The alloy is practically unoxidizable at high temperatures and is especially suitable for the manufacture of gas turbines and for use in the chemical industries where corrosive reactions take place at high temperatures and pressures.

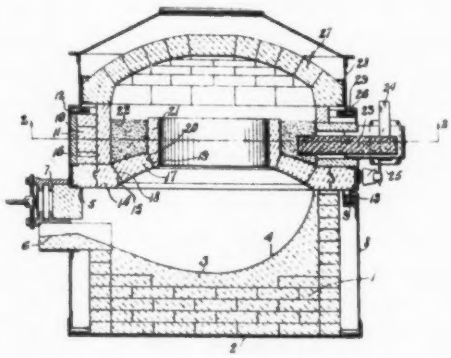
1,505,176, Mold Coating. Stanley M. Udale, of Detroit, Michigan, assignor to Earl Holley, of Detroit, Michigan.

This patent describes a coating material for coating the surfaces of metal molds so that gray iron may be cast therein without imparting an objectionable chill to the surface of the casting or without injury to the mold. The coating consists of fire clay in colloidal suspension in water to which a small amount of soluble silicate (sodium silicate) has been added. In applying the coating the molds are heated above 212 degrees Fahr. and

the solution of sodium silicate and colloidal fire clay applied to the heated surfaces of the mold so that the water is rapidly evaporated and a uniform deposition of the fire clay over the surface of the mold is assured.

1,506,281, **Electric Furnace. Thaddeus F. Baily, of Alliance, Ohio.**

This patent relates to an electric furnace in which the current is passed through a resistance trough located above and surrounding the hearth on which the material to be treated is placed. A novel feature of the invention is the trough containing the resistance material 22 which is supported from



the walls 16 of the furnace by means of the arch member 17 and collar 21 leaving the hearth unobstructed by trough supporting means and easily accessible. The furnace is preferably constructed in three sections, the lower portion 1 supporting the hearth 4 which is provided with a spout or pouring opening 6, partially closed by a suitable door 7. The intermediate section consists of a frame 12 enclosing the refractory and insulating members 10 and 11, the outer wall 16 of the resistance trough and the parts of the resistance trough mentioned above. The top section 28 carries the arch 29 which reflects the heat downward through the opening in the collar 21 onto the hearth. The electrodes 23 are inserted into the resistance material 22 on opposite sides of the trough. The three sctions are detachable and by disconnecting the leads from the electrodes 23 can be removed separately from the base 1 to permit access to the hearth portion.

Concluded from Page 634

QUESTION NO. 135. ***From what material should the gears and pinions be made to be used in a galvanizing bath, that is, operated under molten zinc?***

QUESTION NO. 136. *Which is the best pot for sheet galvanizing, one built up from heavy boiler plate, or a cast pot? If a cast pot, about what analysis?*

QUESTION NO. 137. *What is the mechanism of the iodine etch for the deep etching of steel?*

News of the Chapters

STANDING OF THE CHAPTERS

THE relative membership standing of the chapters has not been published in TRANSACTIONS for some time; however, from now on, it will be included. Wonderful progress has been made by the chapters in the past few months as is evidenced by the listing given below, which shows the present standing of the chapters. The figures in parentheses give the present membership of each chapter. It will be interesting to see how these figures change from month to month.

I	II	III
1. Detroit (284)	1. Hartford (128)	1. Lehigh Valley (107)
2. Pittsburgh (272)	2. Golden Gate (94)	2. New Haven (56)
3. Chicago (259)	3. Syracuse (75)	3. Tri City (54)
4. Cleveland (212)	4. Milwaukee (69)	4. Worcester (45)
5. Philadelphia (211)	5. Cincinnati	5. Los Angeles
6. Boston (201)	6. Indianapolis	6. Washington
7. New York (193)	7. Buffalo	7. South Bend
	8. North West	8. Schenectady
	9. St. Louis	9. Providence
		10. Rockford
		11. Springfield
		12. Rochester
		13. Toronto

CINCINNATI CHAPTER

THE Cincinnati chapter of the American Society for Steel Treating held a meeting on Thursday, October 9th at the Ohio Mechanics Institute, at which time an illustrated paper entitled, "The Romance of Steel", was presented by W. R. Klinkicht, engineer of tests with the Pollak Steel Company of Cincinnati. This paper covered briefly the early history of iron and steel making and the methods of forging. The most important steps in the development of the industry were clearly set forth, and photographs were shown of various pieces of equipment, which were responsible for the development, including the first drop hammer, Kelly's Tilting Furnace, the first steam hammer, and ancient and modern types of hand-fed blast furnaces.

CHICAGO CHAPTER

A very interesting program is being prepared by the members of the Chicago chapter. They have already had the film of LaClede-Christy Com-

pany on Refractories, and found the interest in refractories among their members very great and the discussion interesting.

At the November meeting, H. Bornstein, chief metallurgist of the John Deere Company and former chairman of the Tri City chapter, will talk on his recent trip to Europe and his observation of European methods and plants.

At the December meeting, E. J. Janitzky, chief metallurgist of the Illinois Steel Company, will give a practical talk on heat treating.

The January meeting will be held at the University of Chicago when Doctor Lemon of the University faculty will present actual demonstration of the composition of solids.

Preparations are not quite complete for the February meeting, but it is expected to have a visit from the national officers, with Doctor Jeffries of Cleveland presenting the principal address.

CLEVELAND CHAPTER

The Cleveland chapter of the American Society for Steel Treating held its first meeting of the season on Friday evening, September 19th, in the Cleveland Engineering Society Rooms at Hotel Winton. The speaker of the evening was Major R. H. Smith, vice-president of Lamson and Sessions Company, who gave an excellent resumé of his work on "High Tensile Strengths with Low Carbon Steels." He describel a method of developing astonishing high tensile strength without brittleness in steel with less than 0.15 per cent carbon. His paper was well illustrated with charts and photomicrographs. The interest with which this paper was received is indicated by the fact that the discussion following, lasted fully an hour. The meeting room was crowded to its capacity, about 140 members and guests being present. This was considered an unusually good attendance, especially in view of the fact that many members had already left the city in order to drive through to Boston. The dinner preceding the meeting was also well attended.

The second monthly meeting of the Cleveland Chapter was held in the Cleveland Engineering Society Rooms, Hotel Winton, Friday evening, October 17, 1924. Reports on the Boston convention were given by Prof. H. M. Boylston, and by the National Secretary, W. H. Eisenman. Don H. Stacks, consulting metallurgist, of Hartford, presented a paper entitled "Inspection and Identification of Steels by Use of the Spark Test," and gave a practical demonstration of the method. Mr. Stacks has carried this method of inspection much further than previous investigators, and has developed his own system. He emphasized the necessity of having a great many standards prepared in order to get good results, especially with alloy steels. This meeting was well attended and much interest in the subject was shown.

A course in the practical heat treatment of steel is being given under the auspices of the Cleveland chapter at Case School of Applied Science, department of metallurgy. This course is for the purpose of giving elementary instruction in the principles of practical heat treatment to the steel treaters of Cleveland and vicinity. It is designed for foremen,

future foremen, salesmen for steel companies and for companies which sell heat treating furnaces or pyrometers, purchasing agents for companies who use heat treated steel parts or tools, and practical heat treaters who have had no opportunity for a scientific education, who desire to get ahead in their profession. A series of twenty evening meetings will be held, about eighteen of them being devoted to lectures, and two to laboratory demonstrations. Other demonstrations have also been arranged. The lectures will generally be one ond one-half to two hours in length and will be fully illustrated. The course is in charge of Professor H. M. Boylston, head of the department of metallurgy, Case School of Applied Science.

DETROIT CHAPTER

The Detroit chapter of the American Society for Steel Treating held a meeting on Monday, October 20th at 8:00 p. m. in the General Motors Building. Howard Scott, physicist, Bureau of Standards, Washington, D. C., presented a paper entitled, "Quenching Media." Mr. Scott was able to give a very interesting and practical discussion of this important subject, inasmuch as the Bureau of Standards has recently made an extended investigation and are now able to give the most accurate data available on the quenching efficiency of various solutions. Dinner was served at 6:30 p. m. preceding the meeting.

GOLDEN GATE CHAPTER

The Golden Gate chapter of the American Society for Steel Treating held a meeting at the Engineers Club, San Francisco on the evening of September 13th. The subject of "Drop Forging", was discussed by J. M. Culverwell, manager of the Kortick Manufacturing Company, who reviewed from its beginning, the progress of drop forging on the Pacific Coast. He went into his discussion exhaustively, not only from the experience of his own organization, but through correspondence with the other drop forging plants on the coast, so that the information given, was authoritative. Finally, he reviewed the future prospects of the Pacific Coast in this connection, and introduced his superintendent, F. A. MacDonald, who took up many of the actual phases of shop work of drop forging, both past and present, showing the modern developments in methods of operation and equipment. He also told of some of the troubles experienced in every shop, and completed a most interesting discussion by answering a number of questions. The subcommittee on educational work, of which Professor A. B. Domonoske, of the University of California, is chairman, reported that they were nearly ready to suggest a complete series of lectures on the history of heat treating, from the ore to the final processes. This work will be in addition to the regular program of each meeting.

Another very successful meeting of the chapter was held on Wednesday, October 8th at the New Peerless Cafe in Oakland. There were over seventy present, who formed a most enthusiastic audience to P. A. E. Armstrong, vice-president of the Ludlum Steel Company. The subject of his paper was "Some Recent Developments in Alloy Steels", and a large

part of the time was devoted to the discussion of the new stainless steels that are being developed.

HARTFORD CHAPTER

The Hartford chapter of the American Society for Steel Treating held their October meeting on the 7th at the Hartford Engineers' Club Room. General T. C. Dickson and Dr. F. C. Langenberg, both connected with the U. S. Army Ordnance department at the Watertown Arsenal were the speakers of the evening, General Dickson choosing for his subject, "X-Ray Testing of Metals", and Dr. Langenberg, "Influence of Temperature on the Shock-Resisting Properties of Various Steels." The information which they gave was obtained in the course of investigations carried out to improve the quality of important ordnance parts. General Dickson's paper described methods of inspection of raw materials and finished parts by means of the X-Ray; while Dr. Langenberg explained how the properties of steel vary when exposed to temperatures below and above normal atmospheric temperature. Both papers were illustrated with lantern slides, and were of great interest and practical value to all concerned with the heat treatment, testing and the use of steel. Dinner was served at the University Club at 6:30 preceding the meeting.

LEHIGH VALLEY CHAPTER

The Lehigh Valley chapter of the American Society for Steel Treating held a meeting on October 10th at the Exhibit Building, which was addressed by Dr. Richard Moldenke, on the subject of "Foundry Coke". Dr. Moldenke's presentation was entertaining and instructive.

LOS ANGELES CHAPTER

A special meeting of the Los Angeles chapter of the American Society for Steel Treating was held on October 17th at the Cafeteria of the Los Angeles Creamery. After the dinner Mr. Armstrong spoke on alloy steel and rustless steel. There were forty present at this meeting.

NEW YORK CHAPTER

The New York chapter of the American Society for Steel Treating held their first formal meeting on Wednesday evening, October 22nd in the Merchants Association Room, Woolworth Building. F. F. Lucas, Western Electric Company, addressed the chapter, giving an interesting account of the methods, equipment, and theory underlying his work in high power metallography. This was supplemented by a description of the photographs presented at the Boston Convention, giving some important evidence on the nature of martensite. This meeting was well attended and an animated discussion lasting over an hour following Mr. Lucas' presentation.

NORTH-WEST CHAPTER

The University of Minnesota through its Extension Division, is offering a course in "Materials Testing." This will be conducted by Professor

G. C. Priester, chairman of the chapter. This course began on Monday, September 22nd at 7:30 p. m. in the Experimental Engineering Building, and will continue for 16 weeks. The general policy of the course is to make it of the greatest possible use to the men who enroll. It will cover a discussion of the standard methods of testing engineering materials, actual testing of the same materials by the latest approved methods, special methods of testing of material used for special purposes, discussion of the specifications required for buying or selling engineering materials, and an outline of the properties of the various useful metals and wood. This course will be of benefit to all who design, heat treat, forge or machine steel and various other metals, or are otherwise employed and wish to know more about the material they are using. It will afford an excellent opportunity to obtain useful scientific knowledge which can be practically applied.

The North West chapter of the American Society for Steel Treating held a joint meeting with the Minnesota section of the American Chemical Society on Friday, October 10th, in Room 100, Chemistry Building of the University of Minnesota. The speaker of the evening was Dr. Samuel L. Hoyt, metallurgist at the Research Laboratory of the General Electric Company at Schenectady, who chose as his subject, "Metallic Single Crystals with the X-Ray Defraction Apparatus." Dr. Hoyt has been doing a great deal of work on crystal structures and his lecture covered the subject thoroughly.

The chapter held a meeting on Wednesday, October 29th, at the Manufacturers' Club, which was in the form of a smoker and general acquaintance meeting. The program included a review by Dr. O. E. Harder of the Society's annual Convention, which he attended as a delegate. Motion pictures were shown and other entertainment furnished.

PHILADELPHIA CHAPTER

A post-convention meeting was held by the Philadelphia chapter of the American Society for Steel Treating on October 3rd, at the Engineers' Club. The three papers, "On Metallurgical Education," by Dr. S. L. Hoyt; "Salt Baths" by Sam Tour and "The Macroscopic Examination of Steel" by V. O. Homerberg, which have been published in TRANSACTIONS, were discussed at this meeting. A practical talk entitled, "Heating the Charge" was presented by H. J. N. Voltman of the W. S. Rockwell Company of New York. This meeting was very well attended.

PITTSBURGH CHAPTER

The regular monthly meeting of the Pittsburgh chapter of the American Society for Steel Treating was held in the auditorium of the U. S. Bureau of Mines Building on the evening of October 7th. The speaker of the evening was J. M. Watson, metallurgical engineer of the Hupp Motor Car Corporation and a very active member of the Detroit Chapter. His

subject was, "Heat Treating Processes as Carried On in the New Jackson Plant of the Hupp Motor Car Corporation" and the talk was splendidly illustrated by motion pictures which were taken by the U. S. Bureau of Mines with the co-operation of the Hupp Corporation. Mr. Watson explained the furnaces and equipment used in the continuous heat treatment of front axles, the pyrometer system by which close and accurate temperature control is attained and recorded, and the cooling system with which the oil quenching baths are kept as a uniform temperature. The case-hardening of steering knuckles and their subsequent treatment was demonstrated in considerable detail. No less interesting and important was Mr. Watson's description of the rigid and close inspection which the various parts must undergo before they are permitted to go into service. At the conclusion of the talk many members of the Pittsburgh Chapter entered into the general discussion which followed and showed by their many questions with what interest they had followed Mr. Watson.

ROCHESTER CHAPTER

The Rochester chapter of the American Society for Steel Treating held its first meeting of the year on Monday, September 29th in the assembly hall of Mechanics Institute. J. J. Desmond, chemist and metallurgist of the North East Electric Company, was the speaker of the evening, and chose for his subject, "Tool Steel and Its Performance". Mr. Desmond's presentation was interesting and instructive, being illustrated by slides which brought out in a forceful manner, some of the points to be observed in obtaining maximum service from tool steel. The chapter has published a booklet containing the program of the meetings for the entire year as well as the membership of the chapter.

SCHENECTADY CHAPTER

The regular meeting of the Schenectady chapter of the American Society for Steel Treating was held on Friday, September 19th in the Edison Club Hall. A discussion of the ôpen hearth process of manufacturing steel, was given by L. F. Johnson, metallurgist with the United Alloy Steel Corp., Canton. This chapter is planning a series of lectures on practical metallurgy.

SOUTH BEND CHAPTER

The South Bend chapter of the American Society for Steel Treating held a meeting on October 28th at the South Bend Y. M. C. A. John D. Cutter, vice-president of the Climax Molybdenum Company presented an interesting paper entitled, "Molybdenum and the Principal Uses of Molybdenum Steels." Mr. Cutter is a nationally known metallurgist and is one of the pioneers in the introduction of molybdenum steels. J. F. McElroy also presented a paper, choosing for his subject, "Machine Shop Practices in England." Much discussion followed these presentations.

ST. LOUIS CHAPTER

The St. Louis chapter of the American Society for Steel Treating held a meeting on Monday evening, October 20th, at 8:00 p. m. in the American Annex Hotel. The speaker of the evening was Robert E. Kinkead, chief engineer, welder division of the Lincoln Electric Co., who spoke on "Electric Welding of Steel." Mr. Kinkead having had broad practical experience in electric welding, covered the subject thoroughly, and the discussion which followed his presentation was interesting and instructive.

SYRACUSE CHAPTER

The Syracuse chapter of the American Society for Steel Treating held a meeting on October 20th at the Onondaga Hotel. T. Holland Nelson, United Aloy Steel Corporation, was the speaker of the evening, choosing "Corrosion Resistant Steel" for his subject. Dinner was served at the University Club at 6:30 preceding the meeting.

TORONTO CHAPTER

On September 26th, the Toronto chapter of the American Society for Steel Treating held a meeting in Room 32 of the Mining Building, at which time Professor E. A. Allcut presented an interesting paper entitled, "Drop Forging."

The chapter held their October meeting on the 10th of the month, and the first lecture of the special course of lectures on the Metallurgy of Iron and Steel, was presented by Professor O. W. Ellis. An interesting discussion followed this presentation.

The chapter held a meeting on Thursday, October 30th in Room 32, Mining Building, University of Toronto, at which time W. S. Bidle, first vice-president of the Society, addressed the chapter on the subject of "Practical Heat Treating." This was a very capable presentation, and the discussion which followed was both interesting and instructive.

WORCESTER CHAPTER

The Worcester chapter of the American Society for Steel Treating held a joint meeting with the Worcester section of the American Institute of Electrical Engineers at Whitinsville, Mass. After short addresses by the chairman of both societies, the meeting was addressed by C. F. Cone of the George J. Hagan Company, who described the installation of electric annealing and carburizing furnaces in the plant of the Whitins Machine Company. Mr. Aldrich of that company spoke about the operation of the furnaces and the reasons influencing the company in their decision to install electric equipment. An inspection was then made of the equipment at the Whitins Machine Company. This company generates its own electricity for daytime operation and has a very fine modern power house. There was an attendance of 117 members and guests at this meeting.

EMPLOYMENT SERVICE BUREAU

The employment service bureau is for all members of the Society. If you wish a position, your want ad will be printed at a charge of 50c each insertion in two issues of the Transactions.

This service is also for employers, whether you are members of the Society or not. If you will notify this department of the position you have open, your ad will be published at 50c per insertion in two issues of the Transactions. Fee must accompany copy.

Important Notice

In addressing answers to advertisements on these pages, a stamped envelope containing your letter should be sent to AMERICAN SOCIETY FOR STEEL TREATING, 4600 Prospect Ave., Cleveland, O. It will be forwarded to the proper destination. It is necessary that letters should contain stamps for forwarding.

POSITIONS WANTED

METALLOGRAPHIST-METALLURGIST wants employment when he returns from Europe on September 15th. Graduated from Ohio State University and took advanced work at Columbia University in metallurgy. Formerly in charge of small heat-treating department. 5 years' experience covers routine analysis, metallography, heat-treating, hardening of tool and high speed steel. Knowledge of non-ferrous metallography and physical testing. Inclined to research work. Can furnish reference. Address 9-20.

TOOL HARDENER desires position. Familiar with drop forge dies, shear knives and all tool steels. 12 years' experience. Can give first class references. Capable of taking charge of hardening room. Location in Los Angeles or vicinity preferred. Address 9-1.

METALLURGIST & CHEMIST. Technical graduate; at present metallurgist and superintendent of heat treating; will consider connection with financially stable organization offering future. 12 years' experience in heat treating all classes of steel, physical, chemical testing, metallurgical research, metallography, inspection, maintenance and installation of pyrometers. Married, 37. Capable executive. Address 10-5.

METALLURGICAL ENGINEER. Graduate of University of Pittsburgh (1922), desires position as metallurgical engineer. Address 10-15.

HEAT TREATER desires position. Has had 14 years' experience, being in charge of four different heat treating plants during that time. Address 11-10.

FOREMAN HEAT TREATER desires position as foreman of heat treating plant or service man for steel company. 20 years' thorough practical experience in tool hardening and heat treatment of steel. During last 12 years has had entire charge of steel treating departments for several large manufacturing concerns. Best of references furnished. Address 11-15.

AN OPPORTUNITY to return to the steel game is desired by young man, age 25. 2 years heat treating and inspection on alloy steels, followed by 3½ years in telephone industry, with unusually varied experience and all around training in inspection planning, training, investigation and supervision and methods of engineering. Technical graduate. Married. Has handled 20 men on heat treating and has obtained results in 5 supervisory positions. Plans to develop eventually into sales organization. Now available. Location unimportant. Address 11-35.

POSITIONS WANTED

FORGE SHOP FOREMAN desires position. Experienced in all kinds of hammer forgings, tool dressing, hardening and carburizing. Can give best of references. Address 11-40.

CHEMIST, METALLURGIST, INSPECTOR, with 12 years' experience in open hearth, rolling mill and laboratory, wants to make permanent connection, where ability and experience will lead to advancement. Familiar with high and low carbon steels. No restrictions as to district. Address 11-45.

CHEMIST AND HEAT TREATER desires position in Philadelphia or vicinity. Experienced in heat treatment of low carbon, high carbon and high speed steel; also carburizing, pyrometry, physical testing and inspection; chemical analysis of ferrous and non-ferrous metals. Will accept position as assistant or anything which will show possibility of advancement. Reasonable salary. Address 11-5.

TOOL HARDENER AND HEAT TREATER desires position. 12 years' practical experience covering all phases of heat treating. Fully capable of taking charge of hardening department. Eastern location preferred, but will go anywhere. Address 11-50.

POSITIONS OPEN

WANTED THOROUGHLY EXPERIENCED HARDENER FOREMAN. Must have executive experience and complete knowledge of heat treatment of high speed, carbon, alloy steels and carburizing. Hardening plant is constructed with all modern appliances. State age, experience and salary expected. Address 11-25.

WANTED GENERAL MANAGER of cold-rolled steel and stamping manufactory in New England. Do not apply unless you have mastered and managed both lines, and have been receiving over $10,000 salary a year. Address 11-30.

WANTED

FOR SALE — ROCKWELL HARDNESS TESTER. Direct Reading No. 2½A with Diamond Cone Point. Slightly Used. Good Condition. Address Keystone Screw Co., Bullitt Bldg., Philadelphia.

WANTED—Used scleroscope. Must be in very good condition. Address 9-15.

WANTED—A used Rockwell hardness tester. Must be in good condition. Address 11-20.

WANTED—Used metallurgical microscope with camera, objectives and polishing equipment. State condition and price. Address 9-5.

Items of Interest

ONE of the recent new developments in the way of labor and money saving devices is that of the carburizing compound cleaner and grader manufactured by the Brown Lynch Scott Co. of Monmouth, Illinois. One of these machines was exhibited at the Boston convention of the Society.

In operating this machine the pot used for case hardening may be dumped, either hot or cold, into the hopper at the top of the machine. This is agitated mechanically and the compound very quickly drops into the machine where it passes over sieves that takes out the remaining particles of scale, slag, clay and other foreign substances, and also where the dust and fine particles are removed.

This may be removed by connecting the machine with a suction fan system, or it may be allowed to settle in the bottom of the machine from which it can be removed readily with a shovel. In either case the machine practically eliminates the dust from the shop, as the machine itself is practically dust proof and very little dust arises from it even when it is not connected with a suction fan system.

The hopper at the top also serves a very important function in separating the treated steel from the compound when the pots are dumped in hot, that is when the steel is of a nature that it can be so handled, as the hopper quickly removes the compound and then may be rolled over to the side of the machine and the steel dumped into a quenching vat.

Stated very conservatively, this machine will reclaim at least 25 per cent more compound than is reclaimed by the hand method, and at the same time it accomplishes this work with 75 per cent less labor than is required when it is done by hand. Therefore, it very quickly pays for itself, in saving of compound and in saving of labor, besides all this a more uniform grade of work is obtained because of the assurance of having the compound properly cleaned.

Bristol Co., Waterbury, Conn., have just published their Bulletin No. 330, describing the new Indicating High Resistance Pyrometer Model 420. This pyrometer is an improvement over any previous model which has ever been brought out and is a very important addition to the pyrometer line. This pyrometer was placed before the public for the first time at the International Steel Exposition of the American Society for Steel Treating held at Boston, the week of September 22nd.

Bulletin No. 261, recently published by the W. S. Rockwell Co., New York, describes some of the development and new applications of the Rock-

well Automatic Rotary Furnace. The advantages from the standpoint of cost of production; for decreased labor cost; for fuel economy; for more comfortable working conditions for operatives; and for increased output per unit of time, labor, fuel and floor space are thoroughly covered.

The United States Civil Service Commission announces the following open competitive examination for the position of junior physicist.

An examination for junior physicist will be held throughout the country on November 19. It is to fill vacancies in the Bureau of Standards, Department of Commerce, at an entrance salary of $1,860 a year. Advancement in pay may be made without change in assignment up to $2,400 a year.

Applicants must have been graduated with a degree from a college of recognized standing, such course to have included as a minimum, mathematics through elementary differential equations and at least 18 semester hours of physics, or they must be senior students in such an institution and furnish proof of actual graduation within three months from the date of the examination.

Examination will be given in the following optional subjects: Electricity, heat, mechanics, optics, physical metallurgy, and radio.

Competitors will be rated on general physics, mathematics through calculus, practical questions on each optional subject chosen, and education, training, and experience. Full information and application blanks may be obtained from the United States Civil Service Commission, D. C., or the secretary of the board of U. S. civil-service examiners at the post office or custom house in any city.

Hoover Steel Ball Co., Ann Arbor, Mich., has purchased the Imperial Bearing Co. of Detroit. The equipment of the latter plant will shortly be moved to Ann Arbor and housed in the Hoover plant. New machinery and equipment, in addition to that purchased from the Imperial Bearing Co., is being added for the production of ball thrust bearings, roller bearings, and ball retainers. The new program does not include the manufacture of annular or radial ball bearings. The personnel of the company remains the same as before, with H. D. Runciman as general manager. S. A. Strickland, manager of the Imperial plant, will be manager of the bearing division. Mr. Strickland has become a director in place of Mr. Dobson who has severed his connections with the company.